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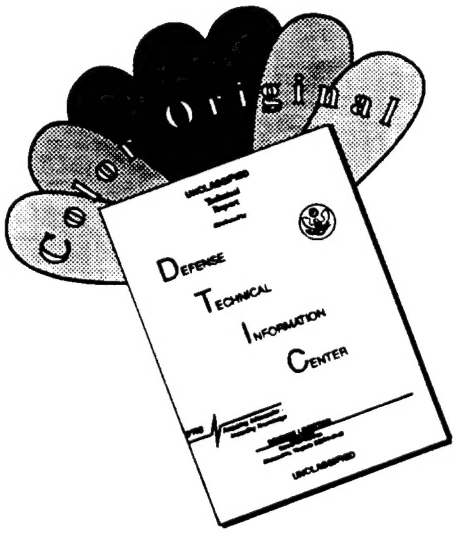

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SUMMARY OF GOVERNMENT-SPONSORED FOREIGN ELECTRONICS: EUROPEAN UNION, GERMANY, JAPAN, SOUTH KOREA, TAIWAN, UNITED KINGDOM, FRANCE, AND SINGAPORE

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October 1994

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Preface

This study provides basic information on foreign electronics R&D sponsored by the governments of the European Union, Germany, Japan, South Korea, Taiwan, the United Kingdom, France, and Singapore. Industrial R&D funding was found to be highly significant in all of the countries studied. Competitiveness is the primary change driver in the electronics industry, whose commercial center of gravity has shifted from the U.S. to the Pacific rim countries. The recent world-wide economic depression has moderated the pace of R&D investment and forced many governments to narrow their aims to the fostering of far downstream, near-product R&D (especially in Germany and the U.K.). Privatization of national laboratories and communications utilities has also been a result of this trend.

Government and industry in the countries studied typically collaborate closely in the planning of economic strategies for capturing new or larger shares of targeted segments of the electronics market. Thus, some European countries are seeking to carve a niche in sensor electronics, while Pacific rim countries are investing in the future by accelerating the improvement of their infrastructures and making themselves more competitive in information technology (IT) and communications (ITC).

National prestige is an issue in these countries and is sometimes measured by the country's technological successes, such as having the fastest computers, the smallest chips, best high definition TV, or the best color flat panel display technology. The patterns of national innovation reflect national priorities and traditional economic and social systems.

The U.S. and the U.K., for example, are rated highly for their upstream capabilities in the innovation process and rated lower downstream; therefore, Asian countries invest in Western countries to get R&D, and Western countries invest in Asia to lower their overall manufacturing and labor costs -- although this is rapidly changing. The complex patterns of cross-investing make it difficult to unravel the relative advantage of any particular company or segment of the electronics industry.

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European Union

- Europe has lagged in IT/ITC R&D investment [ECinfo]: 55% of world expenditure in IT/ITC is by the U.S., 27% by Japan, and only 18% by Europe. Germany, France, U.K., and Italy account for about 80% of EU R&D in IT/ITC. [ECinfo,p.8]
- The EU has recently adopted a Fourth Framework Program (1994-1998) [EUR-OPsupp,pp.1,2]. The purpose of the program is to strengthen European competitiveness in IT/ITC. Table 1. gives a breakdown of finances in the Fourth Framework Program. Table 2. provides a further breakdown for IT and ITC. For an overview of European joint efforts in electronics see Table 3.
- The ESPRIT program (European Strategic Program for Research and development in Information Technologies) is the biggest Community R&D program [ECinfo] undertaken to date. ESPRIT funds 50% of R&D projects involving at least two industrial partners who must provide the remainder. It has become a successful model for the dynamic use of EU funds to enhance pan-European cooperation. However, ESPRIT has also been strongly criticized by the European Court of Auditors [Claveloux,2/14/94,p.14] for being slow, failing to exploit research results, and for bias in the distribution of research funds to the "Big 12," producers who receive 98% of all funds.
- RACE (Research and development in Advanced Communications) was inspired by ESPRIT and is the R&D part of European telecommunciations policy that aims at setting up an integrated broadband communications network by 1995-2000 to supercede the integrated services digital network. RACE (1987-1992) brought together 294 organizations in 92 projects. The EC contributed ECU 550 million of a ECU 1200 million total budget. (1992: 1 ECU=$1.29)
- JESSI (Joint European Submicorn Silicon program) is a EUREKA project launched in 1986 to make European industry capable of mass-producing intelligent chips [ECinfo,p.24]. From 1989-1996, it has been charged with the research and development of memory chips,

semiconductor production equipment and processing materials, computer-aided design tools, and basic research to support industrial objectives. The total budget for the program is estimated at ECU 3.5 billion, half of which is provided by the industrial partners, 25% by national governments, and 25% by the Community. JESSI's technological (as opposed to political) achievements to date are controversial, especially in Germany, where some feel that the joint flagship projects in high resolution television, digital broadcasting, broadband communications, mobile radio, and safety electronics for automobiles have not been very successful. [jprs-est-94-010,p.24-35(pro),p.53-55(con)]

- The European Commission supports the development of European High Definition Television (HDTV) through ESPRIT and RACE as part of EUREKA project 95. Related projects include the RACE 1001 project on digital video technology, the ESPRIT 2283 project on liquid crystal screen technology, and the ESPRIT 2633 magnetic tape project. HDTV is viewed as an important opportunity for Europe in the world market. The funding of HDTV is expected to be approximately $276 million over four years. Matching funds are expected to bring the total up to $486 million [Claveloux,6/28/93].
- The overall convergence of computers, telecommunications, and media into the "electronic highway" [EITO,p.62-63] is viewed as a major challenge and opportunity for Europe to increase its market efficiency and share of the world market and it is driving much of the liberalization and privatization of telecommunications that Europe is currently undergoing in order to compete with the U.S. and Japan.
- EUROBIT, an organization consisting of companies and trade organizations, is the only organization representing the totality of IT industry in Europe [EITO,p.19]. A EUROBIT memorandum has stressed that building the European information infrastructure is the sine qua non for Europe to remain competitive in the global economy.

Germany

- Germany has lagged in electronics R&D and in its relative economic competitiveness in areas such as communications and computers. Only very recently has the semiconductor industry, led by Siemens, begun to warrant cautious optimism, especially in such areas as communications integrated circuits [Vollmer. 3/28/94; Vollmer, 4/24/94].
- The European Commission has approved $36 million in R&D funding for a German nanoelectronics program [Claveloux,4/25/94] that will run from 1994 to 2000. The research will focus on quantum effects that can be exploited in electronics components.
- Germany's first microprocessor, the Hyperstone, manufactured by Hyperstone GmbH, is a 32-bit RISC processor that sells for about $20 [Gosch, 1/25/93]. It is currently being used in telefax, teletext, local area networks, file transfer, and videotext applications.
- The major government-sponsored areas of IT/ITC R&D and their budgets shown in Table 4 [BMFT,p.70] indicate the growing emphasis of federal R&D in IT and microsystems. Table 5 [Kaplan] provides a means for comparing German firms with the top worldwide industrial electronics R&D spenders in relation to sales.
- The BMFT and the German state of Schleswig-Hofstein will be investing DM 250 million ($156 million) in semiconductor R&D [Vollmer,9/27/93]. The main focus is on 0.5-micron ASICs and sensors integrated on a single chip. DM150 million will go the construction of the new Fraunhofer Institute fur Siliziumtechnologie (ISiT) and the rest will be used to purchase equipment. The facility will be managed by Fraunhofer-Inst. e.V.
- In early 1994, the Federal Ministry for Research and Technology (BMFT) approved an expenditure of DM600 million to promote microsystems technology [jprs-est-94-013-L,p.1]. The allocated funds will be available through 1997 and will be used exclusively for "microsystems technology" R&D, which has been

variously defined as a) the integration of sensor functions, signal processing, and actuator structures and as b) the integration of microelectric functions with optical, electromagnetic, mechanical, chemical, and biological functions into a miniaturized solid-state system. The recipients of the special funds for the joint projects will include the national nuclear research centers (GFEs) at Karlsruhe and Juelich as well as the Fraunhofer institutes.

Japan

- Six Japanese firms, each with revenues of more than $10 billion produce almost 85% of Japanese semiconductors, 80% of Japanese telecommunications equipment and 60% of Japanese consumer electronics [Gover quoting Woods,p.59] Fig. 1 shows the "electronics chain." Japanese companies have invested heavily in downstream electronics sectors while being vertically integrated and heavily invested in upstream sectors--especially semiconductors [Gover,p.59] The electronics chain reveals why failures of upstream semiconductor suppliers can have a tremendous impact on downstream profits: downstream manufacturers who are dependent on microelectronics technology become vulnerable to foreign suppliers who compete in the same downstream sector.
- The total amount of R&D expenditure in Japan in 1992 was Y13.9095 trillion, Y138 billion more than in 1991 [JPRS-JST-94-020,p.7]. Fig. 2 shows the changes in research expenditures over the period 1982-1992. The expenditure in communications, electronics, and instrumentation was Y2.2531 trillion. These industries account for 23.6% of industrial and university R&D.
- The Industrial Science and Technology Frontier Program (ISTF) administered by an organization (AIST) within the Ministry of International Trade and Industry (MITI) combines three R&D programs: the National Research and Development Program (large-scale projects), the Research and Development Project of Basic Technologies for Future Industries (next-generation projects), and the Medical and Welfare Equipment Technology Development Program [Foreign Media Note]. The performers are the national institutes and laboratories. Electronics projects in this progam include:

Superconducting Materials and Devices (1988-1997)
FY93 budget: $32.66 million.

Nonlinear Photonic Materials (1989-1998)
FY93 budget: $5.9 million

Silicon-based polymers (1991-2000)
FY93 budget: $5.68 million.

Bio-electronic devices (1986-1995)
FY93 budget: $2.91 million.

New Models for Software Architecture (1990-1997)
FY93 budget: $3.06 million.

Quantum Functional Devices (1991-2000)
FY93 budget: $7.21 million.

Ultimate Manipulation of Atoms and Molecules (1992-2001)
FY93: $5.01 million.

- Table 6 [FBIS-EAS-94-120-A] presents the budgets for MITI's Electronics-related Draft Budget of the Ministry of Posts and Telecommuncations (MPT) and by Specific Measures (Unit:1 million Yen). Funding for 1994 computer R&D declined 1.1% to Y1.86 billion. Some of the funding will go to the Fourth-Dimension Computer Project [FBIS.S&T Persp. 9/15/92] which takes as its major research areas: massively parallel processing systems, large-scale neural networks, and optoelectronic elements and optical connectors. This project will attempt to improve and apply the technologies of the Y54-billion, 10-year, Fifth-Generation Computer Project which MITI initiated in 1982.
- In 2010, multimedia is expected to become a Y123 trillion market. The MPT FY94 budget includes 717 million yen for multimedia information infrastructure projects including:

  - New Information Flowback Promotion Center
  - Municipal Fiber-Optic Program
  - Telework Center

- MPT has been allocated Y22 billion from the FY94 supplementary

budget for multimedia-related projects including:

- Pilot Model Project for a New Generation Communications Network (see Table 7)
- Full Network Support Program
- Sophisticated Image Communications Technology R&D Program
- Three-Dimensional High-Definition TV (HDTV) Programming Technology R&D Program.

• Despite its strong position in the global electronics market, industry reports indicate uneasiness due to the current recession, the appreciation of the Yen, and competitive pressure from the U.S., especially in the logic component market, and from South Korea, which is aiming at dominating the memory market. [FBIS:Nikkan Kogyo Shimbun,1 Jun 94]. The response, promoted by MITI, has been to form the Semiconductor Industry Research Institute Japan (SIRIJ) established by the largest semiconductor manufacturers in Japan. SIRIJ will combat declining competitiveness by creating a think tank charged with analyzing the environment, formulating strategies, and drafting policies. Research findings will be disseminated through the Electronic Industry Association of Japan. The SIRIJ companies are: Fujitsu, Hitachi, Matsushita Electronics, Mistubishi Electric, NEC, Oki Electric, Sanyo, Sharp, Sony, and Toshiba.

SOUTH KOREA

- The total South Korean R&D expenditure in 1975 was $620 million, by 1991 it was $5 billion distributed among research institutes, universities, and industry [Valigra,355]. Table 8 [jprs-kst-94-002,15] shows trends in R&D investment during 1981-1991. Table 9 compares R&D in South Korea, Japan, U.S., Germany, France, and the U.K.. Table 10 [jprs-kst-94-002,17] shows that the private sector contributed over 80% of total R&D expenditure in 1991. The table also compares the relative contributions for Japan, the U.S., Germany, France, and the U.K..
- In 1993, the Taejon Expo '93 initiated the 10-year, $12.5 billion Highly Advanced National Project intended to increase South Korea's global competitiveness in areas ranging from pharmaceuticals to HDTV [Valigra,p.355].
- Korean industry has been allocated $1.9 billion in government funding to develop the Korean computerized information network by the year 2000 [Nak-Hieon,1]. The funding will go to increase the total number of computers and terminals and to increase the market share in domestic computers to 50%. It will also be used to develop 256-Mbit DRAMs, develop a broad-band digital network (ISDN), and to establish a software center to map out a standard translation scheme between Korean and other languages. DRAMS made up 77.3% of Korea's semiconductor exports in 1993 [Nak-Hieon,2/14/94,5].
- The ROK government will invest $125 million to achieve a world standard position in multimedia during the period 1994-1998 [PRER,36]. The Ministry of Trade, Industry, and Energy has developed a "Comprehensive Plan to Develop the Multimedia Industry," which will emphasize revision of regulations to encourage private development.
- The ROK semiconductor industry has been evaluated by a Japanese trade journal as strong in its ability to develop and transfer foreign technology as a compensation for its limited R&D resources [FBISP 93-006,23]. Korea's relatively weak R&D base is

due, in part, to the fact that government and private research labs were only established in the 1970s and 1980s. Korea has focused so intensely on the DRAM market that it has neglected other areas such as flash memories and ASIC. The price of not having a thriving R&D base is high royalty payments to those who do. The major semiconductor firms in Korea pay 10% of their products' value to the U.S. and 2% to Japan.

- The $165 million Kwangju Science and Technical Institute has been established as a government-sponsored S&T university [FBSP 94-006,35]. It will focus on information and communications engineering, new materials, electromechanical engineering, life sciences, and environmental engineering. Its 1994 operating budget is $29.96 million.

- Table 11 gives an overview of some of South Korea's current technology projects [Nak-Hieon,1/25/93,4]. Table 12 lists the companies that are cooperating on a $486 million ATM development project. The Ministry of Communications-designed project will have oversight from the Korea's primary R&D institute, the Electronics and Telecommunications Research Institute.

- Korea will have its first synchrotron radiation source online in the near future after almost seven years of construction. The "Pohang Light Source" or PLS will be used for advanced research in VLSI design, high temperature superconductors, atomic/molecular physics, biology, and medicine [Nak-Hieon,8/23/93,2]. The project cost was $180 million, $73.6 million of which was funded by the Korean government.

- The Korean Ministry of Communications plans to construct its information highway by 2015[Nak-Hieon,8/23/93,10]. Featuring 10 Gbytes/sec speed, the plan for a broadband integrated services digital network (ISDN) to meet the demands of government agencies, research institutions, and corporate R&D centers, will cost $55 billion. Table 13 describes the three phases of the plan.

- The Ministry of Trade, Industry and Energy (MOTIE) is establishing an information-industry complex in Yongin, Kyonggi Province to house 50 or more companies. The companies will share

supercomputers and other equipment in order to foster research and the development of skills in software and systems integration, an area in which Korea has lagged. $43.75 million will be appropriated in the form of subsidies to small and medium enterprises.

- MOTIE will also support R&D in the local semiconductor production equipment industry with a $61.7 million investment, representing 40% of the total investment. Industry will have a guaranteed market among local semiconductor device makers [Nak-Hieon,3/14/94]. Alliances with foreign firms will be encouraged in order to obtain the necessary technologies. According to the Korea Semiconductor Industry Association's statistics, 87% of all production equipment and 63% of materials are of foreign manufacture [Nak-Hieon,5/9/94,6].

- The Korea Institute of Advanced Science and Technology (KAIST) in Taedok Science Town will design and build a 5-Gflops massively parallel computer based on KAICUBE-860, a parallel computer that runs 128 Intel (U.S.) i860 processors at the corners of a hypercube [Nak-Hieon,8/9/93,7].

Taiwan

- Taiwan's Six-Year National Development Plan will cost $300 billion during the period 1991-1996. The goal is to upgrade the island's infrastructure and to foster economic growth [Huang, 1/11/93]. One consequence is that the PC market will grow 10-15%, through institutional purchasing.

- Taipei is considering providing 50% of $92 million in funding to help the expansion of Texas Instruments-Acer in Hsinchu, which makes 4-Mbit DRAMs [Huang,2/22/93]. The manufacturer aims to increase monthly capacity to 15,000 wafers and to progress to 0.50-micron 16-Mbit DRAM technology as part of an overall $300 million investment plan for 1993-1995. TI-Acer is also building a 16-Mbit DRAM plant in Singapore.

- The Electronics Research & Service Organization (ERSO), which is part of the government-subsidized Industrial Technology Research Institute (ITRI) will join Holtek Microelectronics to develop 50-Volt CMOS process technology that is important for liquid-crystal displays and high-definition TV [Huang,2/22/93].

- Taiwan's $280 million submicron project and Texas Instruments (Dallas) will transfer 0.5-micron technology to United Microelectronics, Taiwan Semiconductor Manufacturing Company and Texas Instruments Co. (Taiwan) [Huang,4/12/93]. It is expected that the project will also go ahead on 0.35-micron resolution technology during a test period, although packaging and the lack of a submicron market are considered problems [Huang,7/26/93].

- Figure 3 gives an overview of Taiwan's chip-design industry which had $341 million in sales in 1992, 10% of which is being used for R&D [Huang,5/24/93]. It is common for IC foundries and design houses to get together in order to achieve "up-to-downstream" integration.

- Taiwan's National Nano Device Laboratory (NDL) plans to develop a 0.35-micron for 64-Mbit DRAMs by 1995 and a 0.25-micron

module for 256-Mbit DRAMs by 1998, before forging ahead with 0.1-micron technology [Huang,10/11/93]. NDL will be the only government-subsidized research institution engaged in the development of upstream semiconductor technology when the ITRI becomes a spin-off corporation. The NDL will seek cooperation with equipment suppliers in Holland, France, and Japan to shortcut the R&D.

- A group of nine Taiwanese semiconductor manufacturers are investing $4 billion into new foundries [Huang,11/22/93]. The Hinschu-based Taiwan Semiconductor Manufacturing Co. (TSMC) will build an $800 million 8-inch wafer foundry. ITRI is one of the companies that will be investing in new semiconductor plants. The new foundries and investments are shown in Table 14.
- The Taiwanese government is supporting its cathode ray tube (CRT) industry with $240 million and additional help in the form of land acquisition, technology transfer, and labor [Huang,12/13/93]. The two-phase program is intended to boost the production of 15-inch tubes to 2 million units/year in 1997-1998 and eventually 4 million units/year of 28-in and 36-in CRTs.
- Because of declining competitiveness, the Taiwan Ministry of Economic Affairs has made it possible for Taiwan's information technology industries to invest in China where production costs are much lower. There will still be a prohibition on the 586 personal computer and motherboard manufacturers from investing in China [Huang,4/11/94].
- A 10-year development strategy to boost production in the domestic manufacturing sector to the $320 billion-level by 2002 is being pushed by the Ministry of Economic Affairs. To achieve this goal, which would increase R&D spending to 3.2% of the business turnover, the government would offer long-term tax incentives to companies engaged in R&D, personnel training, and brand-name promotion.
- Taiwan had a total trade volume of $139 billion in 1991. It is estimated to have a total of $600 billion in bank deposits [Wang]. This financial strength is being challenged by a poor

investment climate and a decline in foreign capital investment. The island is short of land and manpower -- especially scientists for conducting basic research. Taiwan will have to invest heavily in these areas to avoid an increasing loss in competitiveness and vulnerability to recession. In order to promote R&D and the development of industrial and high-tech products, the government is further relaxing restrictions on subsidies [Tsai]. Companies with a paid-in capital of $1.85 million or an annual turnover of $7.4 million were entitled to apply for government R&D subsidies. Now, all companies "with a sound financial base" will be entitled to apply for R&D subsidies. Since 1990, the subsidies in the form of interest-free loans have amounted to $103.33 million or one-third of the total $307.40 million expenditure on R&D.

United Kingdom

- In the UK, defense accounts for 30% of all electronics activity [Campbell,3/93]. With the current decline in defense budgets, there is some concern about the impact on key technological capabilities due to cutbacks that will affect smaller companies in the supply chain. Figure 4 shows how the UK Defense Research Agency (DRA) spends its money [Fletcher,9/93]. Seven per cent of its 795.8 million pound budget is spent on electronics.
- According to the UK R&D Scoreboard (an analysis of annual reports filed by companies), the top 10 R&D spenders in the UK invested $3.9 billion in research out of sales of $182.1 billion, or 2.1% of turnover [Kenward].
- Inmos, originally a UK company, acquired by SGS-Thompson (France) has developed the T9000 Transputer, the "fastest monolithic computer in the world" [Anon:New]. This 3.3 million-transistor 10x20mm-chip is rated at 200 million elementary operations/sec and is based on super-scalar architecture and a 64-bit floating point unit.
- British researchers have succeeded in producing ultra-fine, molecular-based wires that cannot be achieved by lithography or even x-rays [Noeldechen]. Long-chain molecules convert out of liquid phase into solid crystals as solvent is removed. The addition of side chains alter the electrical properties of the wires.
- UK Department of Trade and Industry (DTI) is to refocus its 125 million pound budget toward small companies with less than 250 people, and toward technological transfer from overseas [Campbell,7/93]. The idea is for DTI to act as a technology broker that will provide technology advice in a business context and strengthen ties between local businesses and universities.

- Researchers at Cambridge University and the Hitachi European Research Laboratory at Cambridge have jointly developed an 0.03-mm-wide experimental circuit which may eventually lead to a terabit memory [Anon:Memories]. The silicon-doped gallium arsenide circuit is based on two grids of a multiple-tunneling junction to control electron flow, creating a capacitor for load storage as well as a detector for load sensing.

- Sharp Laboratories Europe (Oxford) is a Japanese firm that is currently spending 660 million pounds annually worldwide Billerbeck]. The Oxford laboratory was established in 1990 with an initial investment of 13 million pounds. Because of its predominantly European nature, the laboratory gives the Japanese firm access to the megaprogams of the EU. The work is focussed on basic research in optoelectronics, image processing, information technology (AI/Machine Translation), and liquid crystal technology.

- The UK is expected to experience a higher than average growth, reaching 2.4% in 1993 and 5.5% in 1994 in Information Technology due to an increase in exports and manufacturing output, and an acceleration in business investment [Claveloux,11/93]. Figure 5 shows the growth of the UK's share of the IT market during 1993-1994.

- Britain has the first nation-wide broadband data communications super-highway [Fletcher,12/93]. It is a switched multi-megabit data service (SMDS) system built by the British Telecommunications Plc (BT). The switches provide a range of interfaces to ISDN networks, frame relays, and LANs. An additional asynchronous transfer mode (ATM) capability will be tested in 1994. BT will offer a range of service classes at data rates of 2-, 4-, 16-, and 25-Mbits/second.

- The UK science budget will keep pace with inflation over the next two years at 1.04 billion pounds in 1993/1994 figures, with 1082.3 million pounds to be distributed among the six research councils [Anon. Physics World,1/94]. Table 15 shows the UK science budget for 1993-1997.

- The Association of Franchised Distributors of Electronic

Components (AFDEC) is expecting a 9.1% growth for all components and 11.4% for semiconductors in the UK semiconductor market in 1995 [Fletcher,1/10/94] see Figure 6.

- The UK Department of Trade and Industry (DTI) has established a 3-million pound scheme to promote the production and use of application-specific integrated circuits (ASICs). The Microelectronics in Business scheme will encourage electronics companies to use the customized circuits--currently only 60% of such firms have adopted the technology. ASICs will play a major role in HDTV [Sietmann,2/94].

- The gross expenditure on R&D in the UK during 1992 was 2.12% of GDP, an increase of 4% over 1991 to 12.6 billion pounds [UK Stat.Off]. Civil R&D expenditure was 10.4 billion pounds (+5%) with business spending 7.9 billion pounds, the government spending 2 billion pounds, higher education spent approximately 2.1 billion pounds, and private/non-profit sources spent 0.5 billion pounds. The government contributed a third of all R&D funding in 1992, nearly 30% of civil R&D, and about two-thirds of the funding for defense R&D.

- The UK will spend 15.4 million pounds of the 1994-1995 budget on "wealth creation initiatives" [Anon.,3/94]. 7.5 million is additional money. Figure 7 shows the distribution of total funds among the research councils.

- The UK's LINK scheme promotes collaborative R&D between industry and academia [Campbell,3/94]. LINK is a special funding framework that is oriented toward the marketplace and wealth-creation. Generic technologies are not supported except in their near-market applications. The UK Department of Trade and Industry (DTI) supports LINK with 16 million pounds per year. DTI will be reducing funding for LINK, Eureka, and the Advanced Technology programs from 95.5 million pounds in 1993-1994 to 68 million pounds in 1994-1995, and to 49.9 million pounds in 1995-1996 [Anon. PhysWorld,4/94].

- Fifteen expert 15-20-member panels are being established to examine national technology and future competitiveness

[Rodgers,4/94]; see Table 16. The IT and electronics panel make forecasts about probable directions in silicon, memory density, mobile communications, battery technology, displays, switching, optical fibers and multimedia.

France

- The 1994 budget favors small and medium enterprises (SMEs) [Mattei&Farhi]. The Budget Ministry claims an increase in research funding of 10% while the Research Ministry claims the increase is only 3.5%, the difference probably being due to the difference between allocated and disbursed funding. The civil service research budget of Fr51.6 billion represents an increase of 3.7% over the annual tax act which inflicted a deep cut on the 1993 budget. An additional Fr4 billion has been allocated as research tax credits (RTC). Companies that perform 44% of R&D and having revenues of Fr100 million or less will take 59% of the RTC. Large companies will receive 25% of the RTC and the electronics industry, in particular will receive 13.8% of the RTC. Software firms are also going to benefit considerably from research tax credits.

- The 1994 Civil Research and Development budget presented by Francois Fillon gives priority to medical research [Anon.,AFP Sciences]. The budget includes an increase of Fr100 million for medical research on AIDS, genetics, pharmaceuticals, and clinical research. The second priority is industrial research as noted above. For a breakdown of the 1994 budget see Table 17.

- A national research alliance is being formed to connect the golden quadrilateral of Toulouse, Grenoble, Besancon, and Paris. The Laboratory for Electronics and Information Technologies (LETI) has acted as a catalyst for the alliance of LETI in Grenoble, the Laboratory for Automation & Systems Analysis in Toulouse, the Marne-la-Vallee ESIEE, the Franche-Comte Microtechniques Institute, the Chemical Industry Technical Center in Besancon, and the Chemical Microsensors Club in Lyon. Corporate members include Sagem, Sextant Avionique, Schlumberger, Seb, and

the Puegeot-Renault consortium. A microsystem extends current chip manufacturing technologies to add sensors and actuators, thus combining sensing, processing, and actuating electronics. France is believed to rank fourth in microsystems technology after Japan, the U.S., and Germany, with only half the funding resources of Germany.

- SGS-Thompson Microelectronics NV (Agrate-Brianza) is a state-financed semiconductor manufacturer owned by French and Italian industrial groups [Gee,2/22/93]. ST is expecting $500 million in French and Italian funding to help lift its current 2.7% share of the world semiconductor market to 5% by the year 2000. Since 1987, ST's sales have increased by an average of 14% annually. ST is the first chip company with a European 8-inch fab that is located in Crolles, France. See Table 18 for SGS-Thomson's position (5) among the top ten semiconductor companies in 1993.

- Electronics manufacturer's, represented by the French lobbying organization SPER, are requesting an increase in military spending to avoid losses in earnings due to declining sales: since 1992 sales have declined by 5% to Fr40.6 billion ($7.4 billion) [Gee,4/26/93]. The French government is being urged to introduce a 5-year weapons program to overcome a 16% slump in orders.

- The Flat Panel Display BV joint venture has been approved by the European Commission [Claveloux,5/10/93]. Philips Electronics NV, Thomson SGS, and Sagem will form a company that will design, manufacture, and sell active-matrix liquid crystal displays. The new firm will be the first to produce very large liquid crystal display screens. EC approval was necessary to overcome anti-trust objections.

- Total sales of consumer electronics in Europe have decreased by 4.2% to $3.95 billion in 1992 down from $4.13 billion in 1991 [Vollmer,9/13/93]. France had 17.6% of the consumer electronics market in 1992. See Figure 8.

- The French Ministries of Research, Defense, and Industry have funded a Fr80 million program to assist small and medium-sized enterprises [Anon.,Nachr.]. The Western College of Electronics (ESEO) will assist SMEs in application specific integrated circuit (ASIC) design and provide computer-aided design (CAD) systems, training, and personnel.

- Europe's computer service companies are growing at a remarkably slower rate than expected [Guichardaz,10/93]. France's Cap Gemini Sogeti, a top performer, has announced losses of Fr197 million. The AS/400 relational computing package has done well despite the recession, as has systems integration, however, new systems integrations projects are becoming scarce. Defense data processing and electronics have fared better in France where it has a Fr4-5 billion annual market [Guichardaz,1/94]. The defense data processing market is dominated by four companies: the Sema Group, Syseca, Matra Cap Systemes, and Dassault Electronique.

- Chippac is a two and one-half year European ESPRIT project that will be managed by France's Bull [D.G.]. The purpose of the project is to develop multi-chip modules and single-chip modules that will be suitable for information technology, telecommunications, robotics, and transport. Chippac will develop tools and testing methods to guarantee chip quality prior to assembly. Ceramic and organic substrates will also be studied. Other participants in this project are Framatome, GEC, Marconi UJ, IMC, Alcatel-Mietic, SGS-Thomson, and Telefonica.

- Cie des Machines Bull, a Paris-based company has come under European Union scrutiny because of a $424 million capital transfer and restructuring plan for the ailing company provided by the French government in February 1993 [Claveloux,2/14/94]. A further injection of $1.4 billion was part of another "redeployment plan." Bull received $763 million in December from the government and another $271 million from a share holder, Telecom. These

capital transfers are considered illegal under the EU treaty. The French government has moved to privatize Bull, even offering the Japanese company NEC an option to take a majority stake in the computer firm [Gee,3/14/94].

- France will make an initial investment of $2 billion over the next three years in its version of the electronic highway that will be capable of voice, video, cable and computer data to be transmitted over a single optical fiber network [Gee,3/13/94]. This multimedia strategy will be financed by French taxpayers. France Telecom has already installed 10,000 miles of optical fiber with 20,000 more to come.

- France's ratio of total research expenditures to GDP has been stable around 2.42% [Laperrousaz]. See Table 19 for an indication of the relative position of France's industrial R&D as a percentage of sales, profits, and dividends [Anon. 7/94].

Singapore

- The National Science and Technology Board (established in 1991) encourages R&D activities in Singapore through the Research and Development Assistance Scheme (RDAS), the Research Incentive Scheme for Companies (RISC), and the Patent Application Fund (PAF) [USIS,Invest]. RDAS projects which are judget to have good potential for commercial success are provided with up to 50% of project costs by the government. RISC projects, which involve significant scientific or technical training are eligible for up to 50% of incremental total research spending for 5 years. PAF can provide up to $19,000 of patent applications costs for work conducted in Singapore. The NSTB also finances local training, upgrading, and international R&D manpower recruitment through Manpower Development Assistance Schemes (MDAS)[NSTB].

- The NSTB is also responsible for the National Technology Plan (NTP) to set the national direction of S&T in Singapore. Two important goals have been set: total national expenditure on R&D should reach 2% of GDP by 1995 with the private sector accounting for approximately 50%, and the ratio of research scientists and engineers as a proportion of the labor force should reach 40 per 10,000 by 1995. The government will commit $2 billion in support industry-driven R&D over five years with additional financial support for recruitment, incentives, commercialization, and for the development of infrastructure [NSTB].

- R&D expenditure in Singapore has risen from $38 million or 0.2% of GDP in 1978 to $756.8 million or 1.1% of GDP in 1991, with industry providing 58% of the total expenditure [NSTB].

- The Economic Development Board is promoting the use of Information Technology (IT) as a critical tool for linking

companies and their operations together. Over the period 1989-1991, 346 companies were supported in the implementation of the National Automation Programme, which amounted to $283 million in loans [MIA]. Thirty percent of the amount financed went to small and medium size companies. The NAP also established the Institute of Manufacturing Technology (Nanyang Technological University) to spearhead new industry-driven R&D.

- Singapore has established the German-Singapore Institute, the French-Singapore Institute, and the Japan-Singapore Institute to provide training in various advanced manufacturing and engineering areas, including factory automation, electronic design & automation, and mechatronics.

- The National Computer Board (NCB) was established in 1981 and is dedicated to the development of information technology. The NCB is charged with the computerization of the Civil Service and with the promotion of information technology in the private sector.

- The NCB of Singapore initiated the IT2000 Study in January 1991 with the aim of transforming Singapore into the Intelligent Island where an advanced National Information Infrastructure (NII) would interconnect everyone on the island, with the computer becoming an appliance [Motiwalla]. The ultimate goal is to make Singapore a global hub, an efficient economic switching center for global business, public services, and transportation.

- Corporate tax rates were lowered in 1993 from 31 to 27% and will eventually reach 25% as a way of stimulating the economy [USIS, Invest]. Tax policy is used to enhance Singapore's international competitive position: there are no taxes on capital gains, turnover, or development.

- Table 20 shows the top ten manufacturing industries in

Singapore for the period 1989-1991 [MTI]. See Table 21 for a quick overview of Singapore's major industries (1992:Electronics -- S$16.44 billion or $14.7 billion) and other basic financial and government information. Electronics accounts for 40% of Singapore's total manufacturing output and 40% of its exports [Gee]. Singapore makes approximately half of the world's disk drives (18 million devices) valued at $8 billion. Figure 9 shows electronic products boosting total manufacturing over the period 1992-1994. Figures 10 and 11 provide an overview of Singapore's leading export industries and its competitiveness over the period 1967-1989 [IMD]. Figure 12 gives a breakdown of the information technology (IT) industry in Singapore [IT].

Appendix A: Tables

Table 1.

BREAKDOWN OF FINANCES IN THE FOURTH FRAMEWORK PROGRAMME

Field	Funding (in million ECU)
ACTIVITY 1 – RTD AND DEMONSTRATION PROGRAMMES	10 686
I. Information and communications technologies	3 405
1. Telematics	843
2. Communication technologies	630
3. Information technologies	1 932
II. Industrial and materials technologies	1 995
4. Industrial and materials technologies	1 707
5. Standards, measurements and testing	288
III. Environment	1 080
6. Environment and climate	852
7. Marine sciences and technologies	228
IV. Life sciences and technologies	1 572
8. Biotechnology	552
9. Biomedicine and health	336
10. Agriculture and fisheries	684
V. Energy	2 256
11. Non-nuclear energy	1 002
12. Nuclear fission safety	414
13. Controlled thermonuclear fusion	840
VI. Transport	240
14. Transport	240
VII. Targeted socio-economic research	138
15. Socio-economic research	138
ACTIVITY 2 – INTERNATIONAL COOPERATION	540
ACTIVITY 3 – DISSEMINATION AND EXPLOITATION OF RESULTS	330
ACTIVITY 4 – TRAINING AND MOBILITY OF RESEARCHERS	744
TOTAL	12 300

Source: [EUR-OPPsupp] EUR-OP News. Supplement to EUR-OP News Summer 1994. European Information Technology Observatory 94. (EITO), 1994.

INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICT)

Table 2.

A new information society is emerging, in which management, quality and speed of information are the key factors for competitiveness, growth and employment. Three specific programmes will contribute to the creation of this new information and communication infrastructure.

1. TELEMATICS APPLICATIONS (total amount ECU 843 million)	Funding (in million ECU)
Telematics for services of public interest	**385**
Administration	48
Health care	122
Transport	204
Telematics for knowledge	**142**
Research	48
Education and training	66
Libraries	28
Telematics for improving employment and the quality of life	**121**
Urban and rural areas	38
Elderly and disabled people	62
Environment (exploratory action)	21
Horizontal RTD activities	**131**
Telematics engineering	81
Language engineering	38
Information engineering	14
Horizontal actions	**41**

Emphasis in RTD in this field will be shifted from 'data telematics' to the new 'multimedia telematics'. Telematics of public interest will remain a priority and new domains will be covered (see table).

2. ADVANCED COMMUNICATIONS TECHNOLOGIES (total amount ECU 630 million)	Funding (in million ECU)
Interactive digital multimedia services	150
Photonic technologies	112
High-speed networking	75
Mobility and personal communications networks	119
Intelligence in networks and service engineering	100
Quality, security and safety of communication and systems services	43
Horizontal actions	31

The work under this action will consolidate European technological leadership in digital broad-band communications and develop the technological basis for the deployment of optical fibre networks. It will ensure mobility both on fixed networks and through advanced wireless, radio and satellite systems across Europe, with particular emphasis on user access in public and private networks.

3. INFORMATION TECHNOLOGIES (total amount ECU 1 932 million)	Breakdown of funding (in %)
Software technologies (emerging technologies, distributed information processing)	14
Technologies for components and subsystems (semiconductors, microsystems, peripherals)	23
Multimedia technologies (integrated personal systems)	8
Long-term research (networks of excellence, upstream RTD projects)	10
Focused clusters (OMI – Open microprocessor systems initiative, advanced computer and networking, technologies for business processes, integration in manufacturing)	45

RTD on software technologies will be concentrated on techniques and best practice directed towards enabling the production of usable, correct, reliable and efficient software.

Source: [EUR-OPPsupp] EUR-OP News. Supplement to EUR-OP News Summer 1994. European Information Technology Observatory 94. (EITO), 1994.

European joint R&D efforts in electronics

	Materials	SME and ATE[1]	Components	Computer equipment	Business equipment	Software	Telecommunications equipment	Consumer electronics	Instruments	Telecommunications services	Data-processing services	Other high-technology services
Brite/Euram (industrial technology/materials), 1989 on	●	●	●									
Joint optoelectronics research scheme, UK, 1982 on	●	●	●	●	●							
Alvey (electronics, information), UK, 1983–88		●	●	●	●	●	●	●	●			
Mega project (memory chip), West Germany and the Netherlands, 1983–89	●	●	●	●	●	●						
Distributed computing system, UK, 1984–86		●	●	●	●	●	●					
Esprit (information), Phase I, 1984–88	●	●	●	●	●	●	●	●	●	●	●	●
Eureka (market exploitation), 1985 on	●	●	●	●	●	●	●	●	●	●	●	●
Suprenum (supercomputer), West Germany, 1986–89				●	●	●	●	●				
Transputer (parallel processor), UK, 1987–91		●	●	●	●	●	●	●	●			
Link (precompetitive technology), UK, 1988–93	●	●	●	●								
RACE (communications), 1988–93	●	●	●	●	●	●	●	●	●			
Esprit, Phase II, 1989–94	●	●	●	●	●	●	●	●	●	●	●	●

Sources: Jacob Blackburn, U.S. Embassy, London; European Government documents; the European Community

1. Semiconductor manufacturing equipment and automatic testing equipment

Source: Kaplan, G. and A. Rosenblatt. "The Expanding World of R&D," IEEE Spectrum, October 1990, p. 32

Table 3.

Table 4.

Federal R&D Expenditure by Promotion Areas and Promotion priorities

-DM Million-

Promotion Area	1990 --Actual--	1991	1992 --Gov.Draft--	1993
Information Technology, including Production Engineering	735.7	855.1	1,030.6	1,045.2
Computer Science	207.4	232.5	209.7	215.3
Basic Information Technologies	355.9	395.8	542.7	553.4
Application of microsystems, including microelectronics and microperipherals	64.8	98.4	140.3	140.6
Production Engineering	107.6	128.5	137.9	136.0

Source: Federal Ministry for Research and Technology [BMFT]. Report of the Federal government on Research 1993 (Abridged Version), Bonn, July 1993.

Top electronics R&D spenders in relation to sales*

Company	Country	R&D expenses, in U.S. dollar millions	Percent of sales
Northrop	U.S.	3457	59.6
Lockheed	U.S.	3959	38.0
TRW	U.S.	1879	27.0
Advanced Micro Devices	U.S.	208	19.0
Harris	U.S.	389	17.6
CAE	Canada	104	15.2
National Semiconductor	U.S.	235	14.2
Smiths Industries	UK	168	14.1
Rohde & Schwarz	Germany	66	14.0
Rockwell	U.S.	1600	13.4
Sun Microsystems	U.S.	234	13.3
Tektronix	U.S.	189	13.2
Northern Telecom	Canada	578	13.1
Tandem	U.S.	169	12.9
Mitel	Canada	45	12.8
Data General	U.S.	165	12.1
Digital Equipment	U.S.	1525	12.0
Honeywell	U.S.	678	11.6
Groupe Bull	France	621	11.3
LM Ericsson	Sweden	576	11.3
Intel	U.S.	318	11.1
Siemens	Germany	3693	10.9
Prime	U.S.	174	10.9
GEC	UK	1196	10.4
Hewlett-Packard	U.S.	1019	10.4
Fujitsu	Japan	1929	10.3
Ciba-Geigy	Switzerland	1231	10.2
Thomson SA	France	1275	10.2
Norsk Data	Norway	45	10.0
IBM	U.S.	5925	9.9
Nixdorf	Germany	299	9.9
Ascom	Switzerland	158	9.6
Control Data	U.S.	336	9.3
AMP	U.S.	253	9.1
STC	UK	379	9.0
GE	U.S.	3601	8.9
VDO	Germany	101	8.6
Wang	U.S.	243	8.5
Perkin-Elmer	U.S.	99	8.5
CGE	France	1801	8.4
Philips	Netherlands	2335	8.2
AEG	Germany	619	8.2
Motorola	U.S.	665	8.1
Apple	U.S.	420	8.0
Texas Instruments	U.S.	494	7.9
Bang & Olufsen	Denmark	23	7.4
AT&T	U.S.	2572	7.3
ABB	Switz./Sweden	1300	7.3
Xerox	U.S.	794	7.2
Unisys	U.S.	713	7.2
Schlumberger	U.S.	353	7.2
NEC	Japan	1734	7.1
Oce-Van Der Grinten	Netherlands	66	7.0
NCR	U.S.	416	6.9
Nippondenso	Japan	622	6.8
Eastman Kodak	U.S.	1147	6.7
Plessey	UK	197	6.7
Sony	Japan	1110	6.6
3M	U.S.	689	6.5
Oki Electric	Japan	281	6.5
Ricoh	Japan	363	6.4
AGFA-Gevaert	Germany/Belgium	251	6.3
Olivetti	Italy	399	6.2
Varian	U.S.	83	6.2
Omron Tateisi	Japan	176	6.0
Robert Bosch	Germany	932	6.0
Canon	Japan	512	5.9
Hoechst	Germany	1373	5.9
Diehl	Germany	80	5.9
Toshiba	Japan	1800	5.9
Crouzet	France	23	5.9
Hitachi	Japan	2922	5.8
Matsushita Elec. Ind.	Japan	2493	5.8
Westinghouse Electric	U.S.	706	5.7
ITT	U.S.	516	5.5
Sharp	Japan	535	5.5
Allied Signal	U.S.	647	5.4
Bharat	India	19	5.4
Electronique Serge	France	35	5.2
TDK	Japan	160	4.9
Nokia	Finland	250	4.8
Minolta Camera	Japan	114	4.8
Litton	U.S.	228	4.7
Compaq	U.S.	133	4.6
Sanyo Electric	Japan	434	4.5
Boeing	U.S.	751	4.4
Alps	Japan	130	4.4
Mitsubishi Electric	Japan	926	4.4
BASF	Germany	1016	4.1
Du Pont	U.S.	1319	4.0
Grundig	Germany	78	4.0
EB	Norway	61	4.0
Matsushita Elec. Works	Japan	242	3.9
McDonnell Douglas	U.S.	562	3.9
Kyocera	Japan	102	3.9
Casio	Japan	81	3.8
Pioneer Electronic	Japan	122	3.8
Valmet	Finland	73	3.6
Ford	U.S.	2930	3.6
Eaton	U.S.	122	3.5
STET	Italy	455	3.4
Martin Marietta	U.S.	195	3.4
Zenith	U.S.	51	3.3
Raytheon	U.S.	271	3.3
British Aerospace	UK	327	3.2
Emerson	U.S.	204	3.1
Pitney Bowes	U.S.	80	3.0
Daikin	Japan	66	2.6
E-Systems	U.S.	36	2.5
Teledyne	U.S.	79	2.2
Mannesmann	Germany	251	2.2
GTE	U.S.	297	1.8
BSR	UK	5	1.4
Thorn	UK	74	1.3
Grumman	U.S.	18	0.5

Source: Elsevier Advanced Technology

*Companies were selected within countries to indicate geographic distribution of R&D, rather than by the absolutely largest sales. Thus, companies listed have top sales figures for their respective countries. For example, Italian firms have more than US $1.35 billion in sales; U.S. firms, more than US $1 billion; Japanese firms, US $650 million; UK firms, US $200 million; and so on.

Source: Kaplan, G. and A. Rosenblatt. "The Expanding World of R&D," IEEE Spectrum, October 1990, p. 33.

Table 6(a). Draft Budget of Ministry of Posts and Telecommunications (Unit: 1,000 yen)

* denotes rounding out of figures below 1 million yen.
Items were selected and reorganized by this periodical.
Initial budget for FY93.

Items	FY93	FY94
General account	41,519,915	42,466,648
Of which, revenues from radio wave fees*	7,562,000	7,414,000
Postal services special account	6,906,485,883	7,133,561,275
Postal savings special account	16,015,259,723	16,505,202,876
Post Office life insurance special account	8,436,480,476	10,500,749,258

Table 6(b). MPT's Electronics-Related Draft Budget by Specific Measures (Unit: 1 million yen)

Items were selected and reorganized by this periodical.
Initial budget for FY93.

Items	FY93	FY94
1) Augmentation of informational communications infrastructure to attain balanced national land development		
Projects to fill telecommunication gaps	3,042	2,554
Promotion of specific facilities projects through use of civilian sector capabilities	60	60
Promote sophistication of telecommunications in regional centers and urban areas	12	12
Promotion of information services for regional development	42	39
Promote sophistication of information communications network	79	88
Promote telecommunications enterprises	8	2
Promote sophistication of space telecommunications utilization	21	19
2) Realization of comfortable and affluent livelihood society		
Establishment of telecommunications monitoring system	0	11
Strengthening of information communications environment for safe and secure livelihood	289	832
Buildup of visual software capability	0	27
HDTV dissemination and promotion	26	15
Strengthening of broadcasting services through new broadcasting R&D, etc.	38	32
Expenses for common use of radio waves	7,562	7,414
3) Contributions to international society		
Strengthening international broadcasting	1,789	1,807
Promoting international coordination	12	72
Promoting international cooperation	632	632
4) Promoting information-communication technology development for 21st century		
R&D of basic and advanced technologies	802	837
R&D of space communications technology	1,244	1,424
R&D of measurement technology for global environmental safety	375	429
Advanced R&D in telecommunications field	193	207
Development of frequency potentials	1,002	1,055

FBIS. "FY94 S&T Draft Budget Examined," FBIS-EAS-94-120-A, 22 June 1994, 25-26.

Table 7.

NTT's Next Generation Communications Network Investmant Plan

PURPOSE	CUMULATIVE INVESTMENT PLANNED TO 2015 (trillion yen)	DESCRIPTION
Subscribers Optical Circuits	10	Fiber-optic cables for Sub-scribers' circuits
Digital Communications	10	Digital broad-band communications equipment
Service Software	8	Software for new services
Research and Development	5	Basic research and sophisticated communication network research to strengthen global competitiveness
Support	12	Maintenance of existing services, construction, and business management
TOTAL	45*	

* A little over 2 trillion yen of investmant per year.
(NIKKEI SANGYO SHIMBUN, 13 Jan 94)

FBIS. "Japan: Fiber-Optic Information Superhighway Developments." [Inc. Source], FB PN 94-101, 25 August 1994.

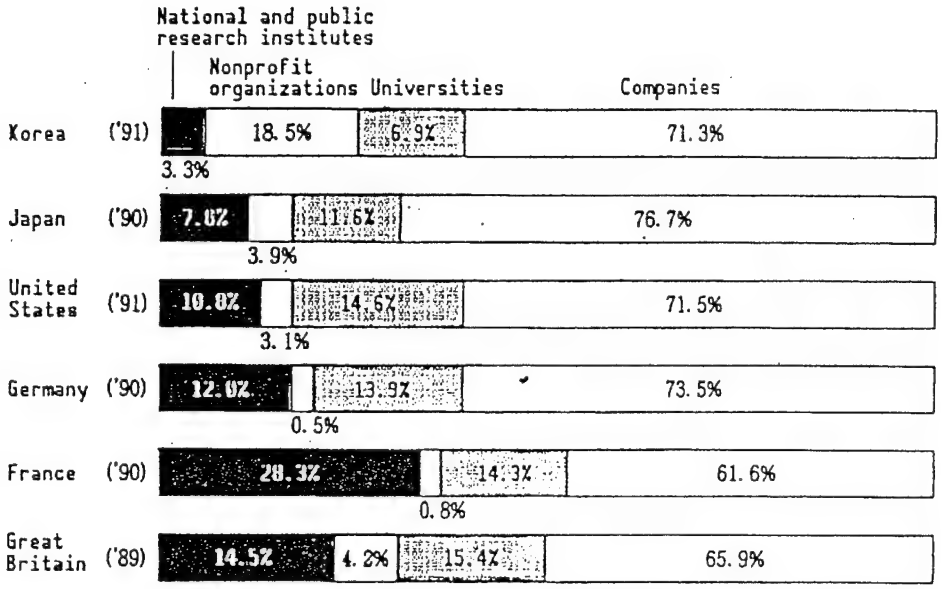
Table 8

Trends in R&D Investment

Year	Current prices		Fixed 1985 prices		As % of GNP
	Amount (billion won)	Percent increase	Amount (billion won)	Percent growth	
1981	368.8	30.5	448.6	11.6	0.81
1982	533.1	44.5	605.8	35.0	1.02
1983	682.2	28.0	738.3	21.9	1.11
1984	907.2	33.0	945.0	28.0	1.29
1985	1237.1	36.4	1237.1	30.9	1.58
1986	1606.9	29.9	1563.1	26.4	1.77
1987	1985.2	23.5	1865.8	19.4	1.87
1988	2454.2	23.6	2177.6	16.7	1.94
1989	2817.3	14.8	2375.4	9.1	1.99
1990	3349.9	18.9	2553.3	7.5	1.95
1991	4158.4	24.1	2858.0	11.9	2.02

Source: FBIS. "Report on Science and Technology R&D Activities," JPRS Report. Science and Technology. Korea. JPRS-KST-94-002. 31 January 1994, 13

Table 9



International Comparison of Utilization of R&D Investment

Source: FBIS. "Report on Science and Technology R&D Activities," JPRS Report. Science and Technology. Korea. JPRS-KST-94-002. 31 January 1994, 15

Table 10

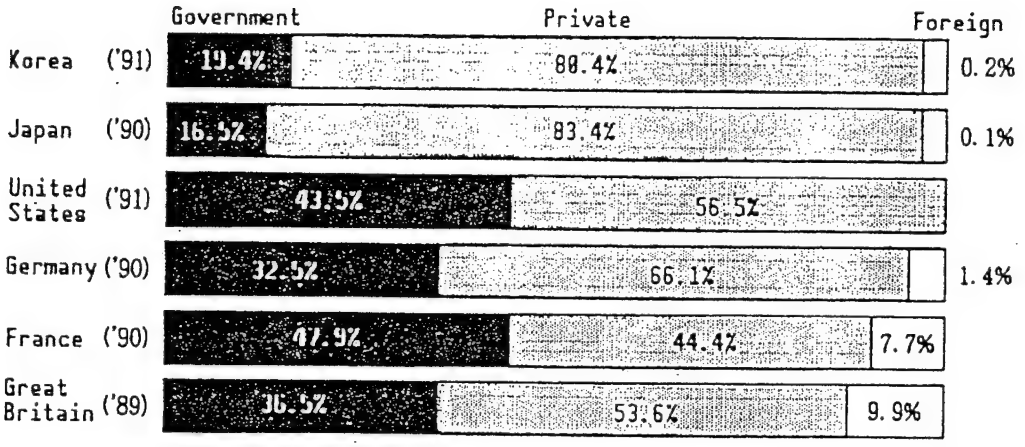


Figure 4. International Comparison of R&D Investment by Source

Composition by Sector of Performance for 1991 R&D Investment

Source: FBIS. "Report on Science and Technology R&D Activities," JPRS Report. Science and Technology. Korea. JPRS-KST-94-002. 31 January 1994, 17

S. KOREA'S CURRENT TECHNOLOGY PROJECTS

G-7 Project—A program designed to upgrade Korea's science and technology capability to the level of the seven leading industrialized nations, the so-called Group of Seven or G7, by the year 2000. It was launched in December of 1991.

Electro-21 Project—A five-year project aimed at the development of 51 key electronic parts in 18 fields from 1992 through to 1996. It was launched in September of 1992 *(see Electronics, 14 September 1992, p. 16).*

ISDN and Satellite Project—Includes two projects: the **ISDN Project,** which was launched in 1987 with the goal of implementing full-scale broadband ISDN service to Korea by the year 2000; and **KoreaSat,** a US$400-million project designed to get critical satellite system capabilities from foreign countries with the launch of a communications satellite by 1995. Both projects are run by **Korea Telecom** in Seoul, the state-run telecommunications monopoly which is being privatized. The two projects will eventually be linked.

Information Industry Promotion Policy—Announced December of 1992 *(see Electronics, 11 January 1993, cover).*

National Computerization Plan—A plan launched in 1989 which built five skeleton information networks in S. Korea.

Nak-Hieon, Kim. "New S. Korean President Plans More Comprehensive Technology Policy," Electronics, 25 January 1993, 4.

Table 12

KOREA LAUNCHES ATM DEVELOPMENT PROJECT

By *Kim Nak-Hieon,* Seoul, South Korea

Korea is pouring US$486 million and allocating 6,300 researchers to develop ATM. The ATM research is part of a larger special project, named the HAN B-ISDN Development Project, which is designed to develop eight key pieces of equipment in four major fields, including ATM exchanges, by 2001.

The Ministry of Communications (MOC), which designed the project in partnership with the Ministry of Science and Technology (MOST), recently chose 10 companies as participants for the ATM part of the project.

Seoul-based **Korea Telecom** will host the project, with oversight from the state-run **Electronics and Telecommunications Research Institute** in Taeduk Science Town, the country's primary R & D institute.

COMPANIES DEVELOPING ATM IN THE HAN B-ISDN PROJECT

- Daewoo Telecom Co.
- Goldstar Information & Telecommunications Co.
- Othelco Co.
- Samsung Electronics Co.
- Dongah Electric Co.
- Woojin Electronics Col
- Daeduk Electronics Co.
- Hyundai Electronics Co.
- Chung Ho Computers Co.
- Dae Young Electronics Co.

Nak-Hieon, Kim. "Korea Launches ATM development project," Electronics, 14 June 1993, 10.

KOREA'S INFORMATION HIGHWAY TIMETABLE

Phase I (1993-1997):

- The government's information networks built for administrative purpose will be upgraded to 155 Mbits/s from the present level of 9.6 kbits/s.
- The government's administration networks will then be merged with various educational networks to form a comprehensive wide-area data communication system.
- Communications cables of public agencies, large business buildings, and educational and research complexes will be replaced with optical cables.
- The development of next-generation information communication equipment and service will be promoted.

Phase II (1998-2002):

- Information communications networks will be further upgraded to the 622-Mbits/s level.
- The installation of optical cables will be expanded to small-sized business firms and densely-populated apartment complexes.
- Commercial multimedia information will be provided.

Phase III (2003-2015):

Electronic super-highway will be completed. The broadband public communications networks will provide multimedia information service to the general public.—*KN*

Nak-Hieon, Kim. "Korea sets sights on ultra-speed information highway," Electronics, 23 August 1993, 10.

Table 14

NEW FOUNDRIES PLANNED IN TAIWAN

	Wafer size	Investment (US$M)	Construction starts
TSMC	8"	$1,000	4Q 1993
UMC	8"	1,000	1Q 1994
TI-Acer	8"	440	4Q 1994
Hualon	8"	440	4Q 1994
Winbond	8" planned	—	—
Macronix	8" planned	—	—
Holtek	6"	—	—
Gov't spin-off	8"	1,600 (by 1999)	—

Jackie Hwang of *Commercial Times*, Taiwan

Source: Huang, Charlene. "Taiwan IC Makers Plan Huge Expansion," Electronics, 22 November 1993, 3.

Table 15.

UK science budget 1993–1997 (£ millions)

	Cash terms	Adjusted for inflation
1993/94	1038.3	1038.3
1994/95	1082.3	1040.7
1995/96	1120.3	1038.3
1996/97	1126.0	1018.1

Source: Anon. "UK Support Keeps Pace," Physics World, January 1994, 11.

Table 16.

Technology foresight panels

- agriculture, natural resources, environment
- chemicals
- communications
- construction
- defence and aerospace
- energy
- financial services
- food and drink
- health and life sciences (including pharmaceuticals)
- IT and electronics
- leisure and education
- manufacturing, production and business processes
- materials
- retail and distribution
- transport

Source: Rodgers, Peter. "Fifteen for the Future," Physics World, April 1994, 13.

1994 Research and Development Budget; Ministry allocations (ordinary expenditures + program authorizations)				
Civilian Research & Development Budget 1994 (FrMillions)	OE+PA	OE+PA	OE+PA	Percent Change
	LFI* 93	LFR* 93	PLF* 94	LFR*
EPST (Public Science & Technology Establishment)				
INRA (Nat'l Agronomic Research Inst.)	3,066.2	3,022.3	2,998.o	-0.8
CEMAGREF*	184.4	180.5	184.1	2.0
INRETS*	210.7	206.2	202.9	-1.6
INRIA (Nat'l Inst. for Research on DP and Automation)	426.2	413.3	427.7	3.5
CNRS (National Center for Scientific Research) + institutes	12,490.5	12,275.4	12,417.1	1.2
INSERM (Nat'l Health & Med. Research Inst.)	2,329.6	2,276.4	2,273.0	-0.1
INED (Nat'l Demographic Studies Inst.)	81.3	79.4	84.7	6.8
ORSTOM	999.5	982.5	1,020.3	3.8
s/TOTAL EPST	19,788.2	19,435.8	19,607.9	0.9
Foundations and Institutions	764.6	747.3	810.0	8.4
EPICS*				
CEA	2,698.5	2,689.7	2,763.3	2.7
ADEME*	263.9	245.2	203.1	-17.2
IFREMER (Fr. Inst. for Research on Exploitation of the Ocean)	946.8	906.8	905.9	-0.1

Source: Anon. "France: 1994 Civil R&D Budget Outlined," AFP Sciences, Paris, 23 September 1993, 1-3. [JPRS-EST-93-041].

Table 17. --Continued

CSI*	609.2	582.5	568.9	-2.3
CIRAD*	667.3	654.1	667.7	2.1
TOTAL EPIC	5,185.6	5,078.3	5,108.9	0.6
s/TOTAL FOUNDATIONS AND ORGANIZATIONS	25,738.4	25,261.5	25,526.7	1.1
Higher Education	2,118.3	2,031.8	2,049.8	0.9
MESR* Administration	2,654.9	2,391.0	2,391.8	0.0
including				
Incentives, information, consult.	29.8	25.3	68.5	170.8
Training for and through research	1,382.6	1,350.6	1,445.0	7.0
CSTI, Future Trends & Research	18.9	17.0	12.0	-29.5
RTF	928.3	728.7	666.2	-8.6
Culture, Scient. & Techn. Information	76.6	70.8	50.0	-29.4
TOTAL MESR BUDGET	30,511.6	29,684.3	29,968.3	1.0
TOTAL OTHER MINISTRIES	23,207.0	22,255.6	22,589.6	1.5
TOTAL CRDB	53,718.6	51,939.9	52,557.9	1.2
* Expansion unknown				

</lit>

<txt>The three tables below provide the key data for the 1994 Higher Education budget. The first gives the corrected figures for 1994 transfers (research allocations, IUFM allocations).

ORDINARY EXPENDITURES	1993	1994
Personnel expenditures	22,257,381,021	23,425,021,677
Operating expenses	4,918,577,983	5,275,516,474

Table 17. --Continued

including 36.11	4,640,515,547	4,927,965,616
Social programs	6,176,681,268	6,848,026,997
including scholarships	4,796,724,026	5,394,724,026
and charitable subsidies	1,379,857,242	1,453,302,971
TOTAL OE	33,352,640,272	35,548,565,148

CAPITAL EXPENDITURES (in FrThousands)				
	1993		1994	
	PA	Approp.	PA	Approp.
Construction	2,276,000	1,747,500	2,010,000	1,768,000
Equipment	545,900	551,900	660,000	594,000
Maintenance	528,000	499,500	530,000	529,000
TOTAL excl. research	3,349,900	2,798,900	3,200,000	2,891,000
TOTAL univ. research	1,854,000	1,789,090	1,786,080	1,771,690
TOTAL capital spending	5,203,900	4,587,990	4,986,080	4,662,690

TOTAL (in French francs)	
OE+PA	
1993	1994
33,352,640,272	35,548,565,148
5,203,900,000	4,986,080,000
TOTAL	
38,556,540,272	40,534,645,148
OE+Approp.	

Table 17. --Continued

33,352,640,272	35,548,565,148
4,587,990,000	4,662,690,000
TOTAL	
37,940,630,272	40,211,255,148

Table 18

Europe's top ten semiconductor vendors in 1993

	$bn	Change on 1992 (%)
1 Intel	2.07	83
2 Motorola	1.19	22
3 Philips	1.10	–3
4 Siemens	1.03	13
5 SGS-Thomson	0.99	11
6 Texas Inst.	0.92	24
7 NEC	0.61	24
8 Toshiba	0.58	24
9 Samsung	0.51	53
10 National Semicon.	0.45	5
Total	**15.10**	**24**

Source: Dataquest

Source: Anon. "US Takes Lead in Europe," Physics World, February 1994, 14.

Table 19

Country	R&D in £bn (% change)	R&D as % of sales	R&D as % of profit	R&D as % of dividend	Number of companies
US	41.2 (+3)	4.4	72	185	81
Japan	26.6 (–1)	5.9	176	856	49
Germany	12.0 (–3)	6.8	481	922	11
France	7.1 (+10)	4.8	163	728	17
Switzerland	5.1 (+3)	6.8	81	425	8
UK	4.7 (+9)	2.3	29	74	13
Italy	2.1 (+1)	3.0	–	–	6
Sweden	1.7 (+13)	7.3	212	621	5
Netherlands	1.6 (–6)	5.7	–	–	3
Canada	1.3 (–13)	8.1	–	264	2
Selected sectors					
Chemicals	13.3 (+4)	6.2	97	247	34
Electronic/ electrical	29.3 (–1)	6.7	277	589	41
Engineering	15.4 (–4)	5.5	167	600	38
Oil	2.7 (–5)	0.8	14	32	11
Pharmaceut.	9.2 (+11)	12.4	68	205	23
Telecoms	7.3 (+9)	5.1	77	201	7
Vehicles	18.8 (+3)	4.6	178	856	19
Top 200	104.5 (+2)	4.8	101	283	200

Source: Anon. "Who Scores Biggest in the R&D Stakes," Physics World, July 1994, 14.

MANUFACTURING, 1989–1991
(TOP TEN INDUSTRIES)

	1991 Value Added (% Share)	1989	1990	1991p
		Percentage Change Over Previous Year		
INDEX OF INDUSTRIAL PRODUCTION (1989 = 100)				
Total Manufacturing[1]	100.0	10.1	9.9	5.3
Electronic Products	33.8	10.0	13.0	0.4
Petroleum Products	8.6	13.7	13.4	3.4
Transport Equipment	7.4	21.6	11.2	4.4
Paints, Pharmaceutical & Other Chemical Products	6.3	18.6	30.5	30.3
Machinery except Electrical & Electronic	6.1	18.1	7.9	11.5
Fabricated Metal Products	6.0	3.9	–1.5	2.0
Industrial Chemicals & Gases	4.7	6.3	13.8	1.8
Printing & Publishing	4.4	10.9	10.2	8.1
Electrical Machinery, Apparatus & Appliances	4.2	13.7	–7.5	9.2
Food	2.7	2.8	–2.4	5.1

[1]Excluding rubber processing

Source: Economic Development Board

Source: Ministry of Trade and Industry. Economic Survey of Singapore. 1991. February 1992, 51.

Data

Major industries: Electronic products and components, US$16.44 billion (US$14.7 billion); petroleum refineries and petroleum products, US$6.9 billion (US$5.22 billion); fabricated metal products excluding machinery and equipment, US$2.14 billion (US$2.11 billion); industrial chemicals and gases, US$1.92 billion (US$1.82 billion); electrical machinery and appliances, US$1.4 billion (US$1.49 billion).

Major imports: Machinery and transport equipment, US$29.2 billion (US$25.5 billion); mineral fuels, US$10.35 billion (US$8 billion); manufactured goods, US$8.43 billion (US$8.2 billion); chemicals, US$4.84 billion (US$4.41 billion).

Major exports: Machinery and transport equipment, US$28.41 billion (US$25.67 billion); mineral fuels, US$10.29 billion (US$8 billion); manufactured goods, US$3.96 billion (US$4.17 billion).

Tourism and transport: Arrivals, 5.32 million (4.83 million); Singapore Airlines national carrier; underground urban railway; extensive bus network and 11,000 taxis; car hire is widely available and cars can be driven into Malaysia.

(All figures for 1990 unless otherwise stated. Previous year in brackets.)

Currency: Singapore dollar (100 cents). S$1.6805 = US$1 in Nov. 1991 (S$1.7015 = US$1 Nov. 1990).

Finance: 13 local banks, 124 foreign banks, including 88 offshore. 180 companies listed on main board of the Stock Exchange of Singapore. A further 14 companies listed in the SESDAQ over-the-counter market and another 129 regional stocks quoted in the CLOB market, including 118 Malaysian.

Major banks: Bank of Singapore, Tong Eng Bldg, 101 Cecil St 01-02, 0106, tel. 2255577; DBS Bank, DBS Bldg, 6 Shenton Way, 0106, tel. 2201111; Far Eastern Bank, 156 Cecil St, 0106, tel. 2210955; Industrial and Commercial Bank, ICB Bldg, 2 Shenton Way, 0106, tel. 2211711; International Bank of Singapore, 02-01 Overseas Union Hse, 50 Collyer Quay, 0104, tel. 2234488; Oversea Chinese Banking Corp., OCBC Centre, 65 Chulia St, 0104, tel. 5357222; United Overseas Bank, 01-00 UOB Bldg, 1 Bonham St, Raffles Place, 0104, tel. 5339898.

Government ministries: Communications and Information, PSA Bldg, 36-00, 460 Alexandra Rd, 0511, tel. 270-7988; Community Development, 512 Thomson Rd, 1129, tel. 258-9595; Defence, Gombak Drive, 2366, tel. 760-8188; Education, Kay Siang Rd, 1024, tel. 473-9111; Environment, 40 Scotts Rd, 0922, tel. 732-7733; Finance, 8 Shenton Way, Treasury Bldg, 0106, tel. 225-9911; Foreign Affairs, 250 North Bridge Rd, 07-00, 0617, tel. 336-1177; Health, 16 College Rd, 0316, tel. 223-7777; Home Affairs, Phoenix Park, Tanglin Rd, 1024, tel. 235-9111; Labour, Havelock Rd, 0105, tel. 533-6141; Law, 250 North Bridge Rd, 21-00, 0617, tel. 336-1177; National Development, 7 Maxwell Rd, 5th Storey, tel. 222-1211; Trade and Industry, 8 Shenton Way, 48-01, Treasury Bldg, tel. 225-9911.

Public holidays (1992): 1 Jan. (New Year), 4-5 Feb. (Lunar New Year), 5 Apr. (Hari Raya Puasa), 17 Apr. (Easter), 1 May (Labour Day), 17 May (Vesak Day*), 11 June (Hari Raya Haji), 9 Aug. (National Day*), 24 Oct. (Deepavali), 25 Dec. (Christmas).

(* Following Monday a public holiday.)

Weather: Singapore has a tropical climate, with regular high daytime temperatures and high relative humidity. Average maximum daily temperature is 30.7°C and average minimum 23°C. There are no distinct seasons, but the northeast monsoon brings heavy showers in Nov.-Jan. Brief showers are frequent throughout the rest of the year.

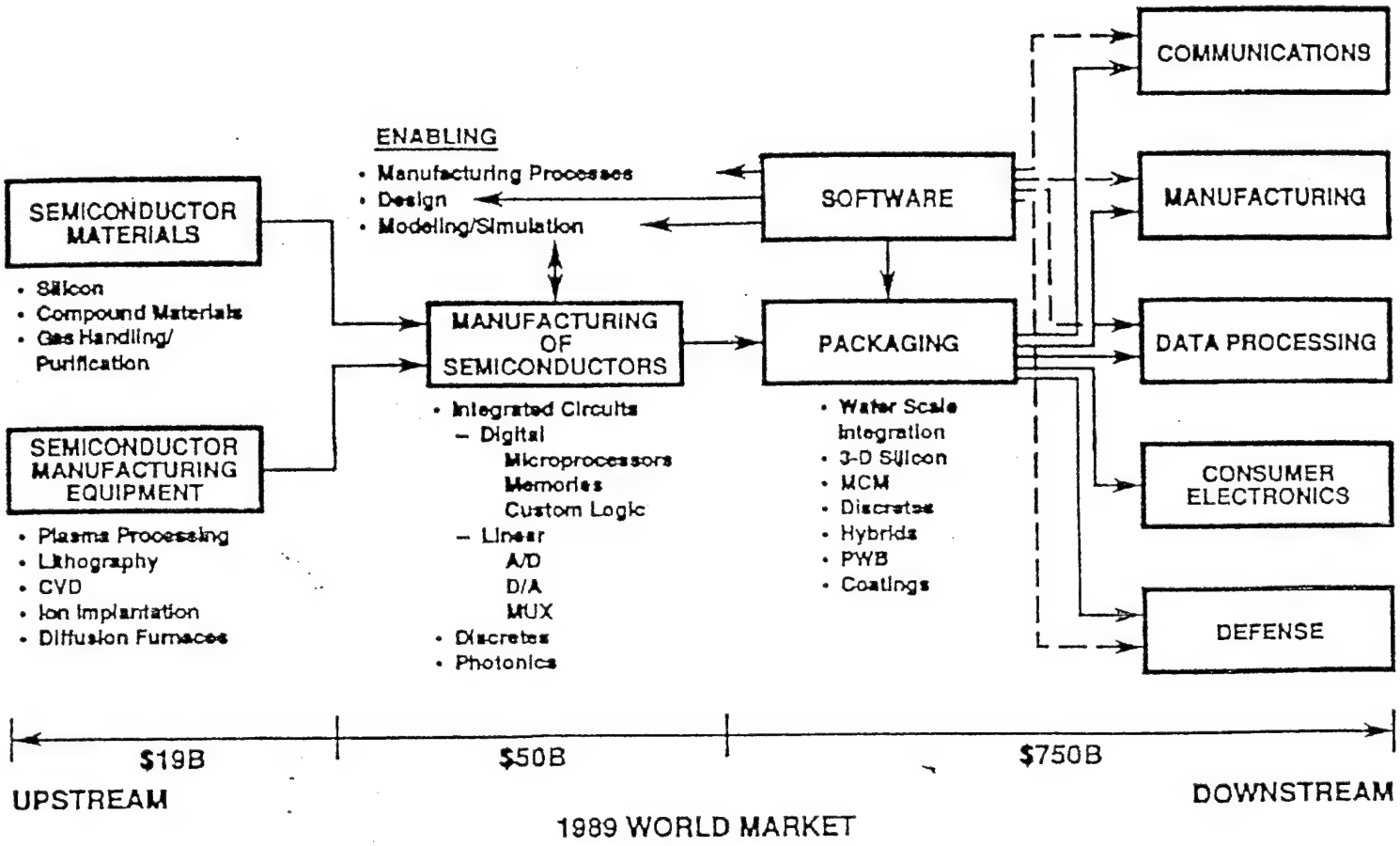
Source: Far Eastern Economic Review: Asia yearbook 1992. 186-189.

Exchange rates against the US dollar (Annual Average)

Country	Currency		1987	1988	1989	1990	1991	1992
AUSTRALIA	Australian Dollar	A$	1.43	1.28	1.26	1.28	1.28	1.36
AUSTRIA	Schilling	Sch	12.60	12.30	13.20	11.37	11.68	11.0
BELGIUM	Franc	BF	37.3	36.8	39.4	33.4	34.1	32.1
BRAZIL	Cruzerio	Crz	39.2	262	2863	68.8	406.6	4502
CANADA	Canadian Dollar	C$	1.33	1.23	1.18	1.17	1.15	1.21
DENMARK	Krone	DKr	6.84	6.73	7.31	6.19	6.40	6.05
FINLAND	Markka	Fmk	4.40	4.18	4.29	3.82	4.04	4.48
FRANCE	Franc	FFr	6.01	5.96	6.38	5.45	5.64	5.29
GERMANY	Deutsche Mark	DM	1.80	1.76	1.88	1.62	1.66	1.56
HONG KONG	Hong Kong Dollar	HK$	7.8	7.8	7.8	7.8	7.8	7.74
INDIA	Rupee	Rup	13.0	13.9	16.2	17.5	22.7	25.9
INDONESIA	Rupiah	Rp	1644	1686	1770	1843	1950	2030
IRELAND	Irish Pound	I£	0.67	0.66	0.70	0.60	0.62	0.59
ISRAEL	Shekel	Shk	1.60	1.60	1.92	2.02	2.28	2.46
ITALY	Lira	Lira	1296	1302	1372	1198	1241	1232
JAPAN	Yen	¥	145	128	138	145	135	127
MALAYSIA	Ringgit	Rt	2.52	2.62	2.71	2.70	2.75	2.57
NETHERLANDS	Guilder	Gd	2.03	1.98	2.12	1.82	1.87	1.76
NORWAY	Krone	NKr	6.74	6.52	6.90	6.26	6.48	6.21
PHILIPPINES	Philippine Peso	Peso	20.60	21.10	21.74	24.31	27.48	25.5
PORTUGAL	Escudo	Esc	141.0	144.0	157.5	142.6	144.5	135.0
SINGAPORE	Singapore Dollar	S$	2.11	2.01	1.95	1.81	1.73	1.63
SOUTH AFRICA	Rand	Rd	2.04	2.26	2.62	2.58	2.76	2.80
SOUTH KOREA	Won	Wn	823	731	671	708	733	781
SPAIN	Peseta	Pts	123.0	116.0	118.4	101.9	103.9	102.4
SWEDEN	Krona	Swkr	6.34	6.13	6.45	5.92	6.05	5.82
SWITZERLAND	Franc	SFr	1.49	1.46	1.64	1.39	1.43	1.41
TAIWAN	Taiwan Dollar	NT$	31.40	28.59	26.41	26.67	26.83	25.0
THAILAND	Baht	Bt	25.70	25.30	25.70	25.59	25.52	25.4
UNITED KINGDOM	Pound Sterling	£	0.61	0.56	0.61	0.56	0.57	0.57
EUROPEAN COMMUNITY	European Currency Unit	ECU	0.87	0.85	0.91	0.79	0.81	0.77

Source: IMF

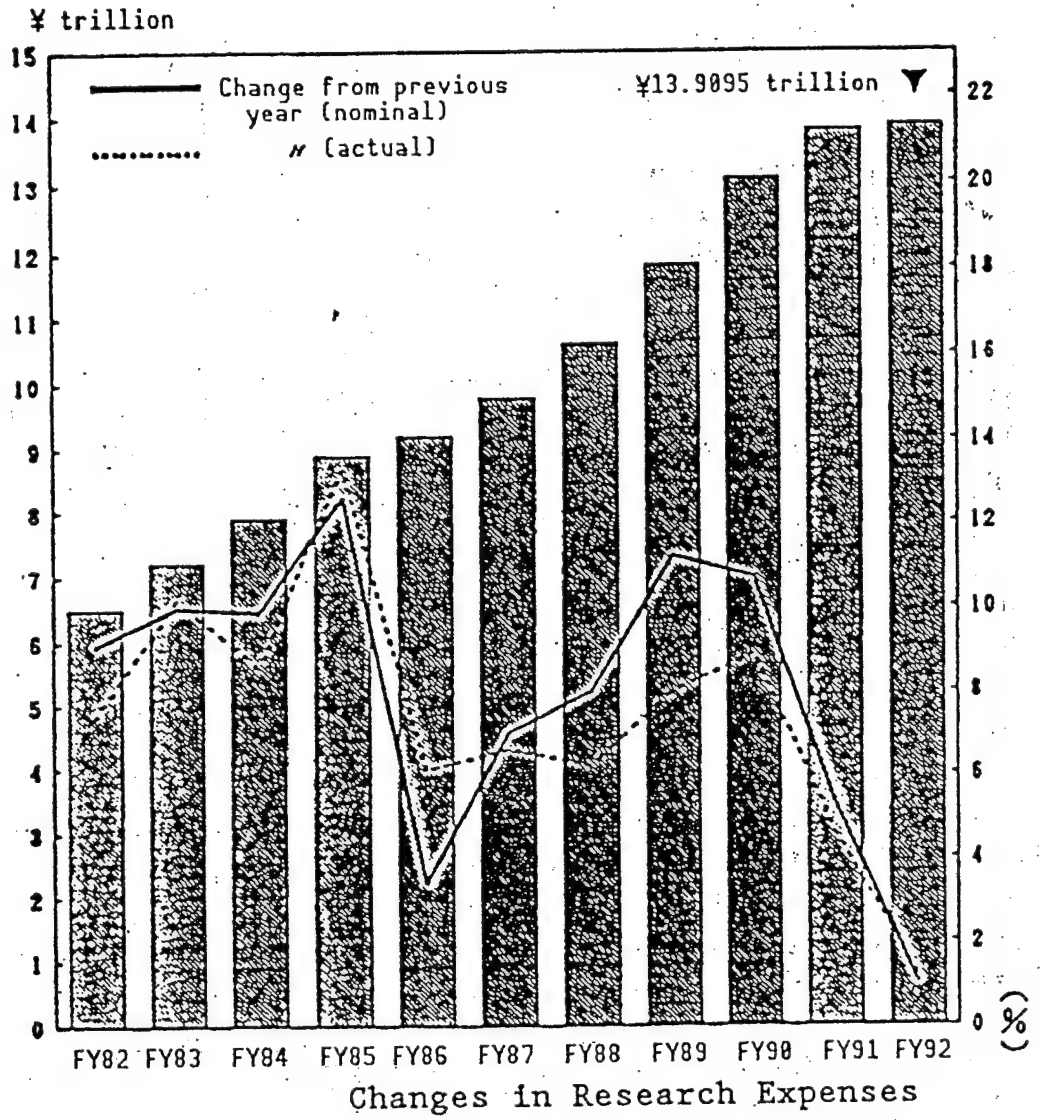
Appendix B: Figures



1989 WORLD MARKET

Source: Gover, James E. "Review of the Competitive Status of the United States Electronics Industry." Pages 57-74 in W. Aspray (Ed.) Technological Competitiveness: Contemporary and Historical Perspectives on the Electrical, Electronics, and Computer Industries. IEEE Press, 1993.

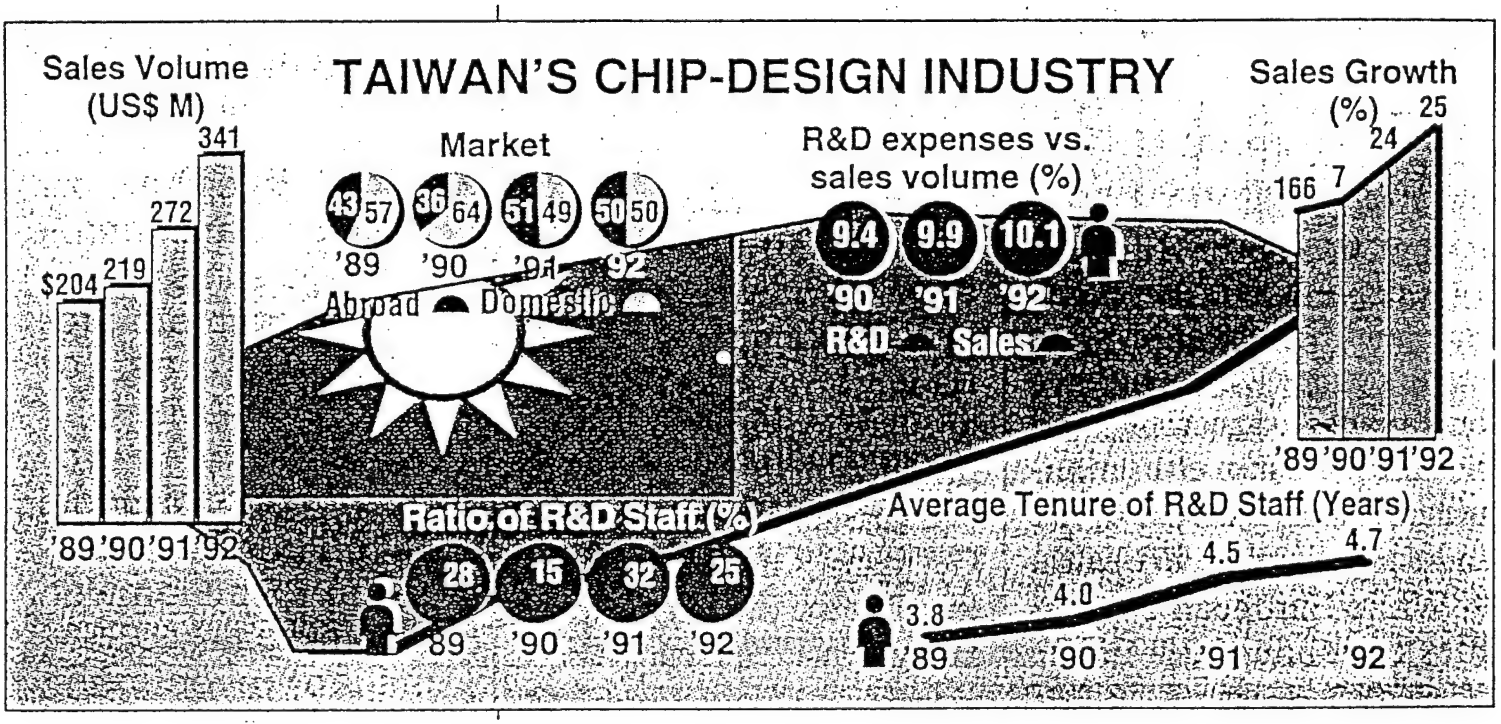
Fig. 1.



Source: FBIS. "Summary of Results of S&T Research Survey." JPRS Report. Science & Technology. Japan. JPRS-JST-94-020, 1 August 1994.

Fig. 2.

Figure 3.



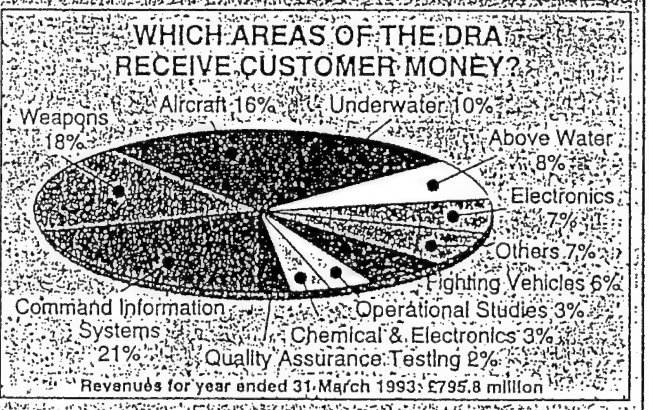
Source: Huang, Charlene. "Taiwan's chip design industry comes of age; firms work to build on growth," Electronics, 24 May 1993, 14.

Figure 4.

WHERE THE DRA SPENDS ITS MONEY

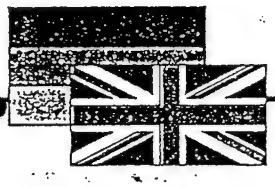
The Defense Research Agency's researchers are deployed where its customers spend their money. Around 15% of the organization's 5,000 scientists specialize in computers and information processing, and some 65 million are committed to the development of command information systems. Major projects include the following:

- The Generic Intelligence Fusion Technology (GIFT), a four-year program, aims to automate collection and collation of data associated with battlefield maneuvers for display on a workstation.
- Project Joust matches the characteristics of jet fighter aircraft by simulating dog-fights.
- MESA solid state radar ensures against both electronic and physical attack.
- An airborne missile guidance system not only recognizes and names different types of aircraft, but fixes its aim at their most vulnerable spots. —*PF*



Source: Fletcher, Peter. "UK Revamps Military R&D Agency," Electronics, 13 September 1993, 4.

Figure 5.



GERMANY, UK LEAD EUROPE'S IT MARKET REBOUND

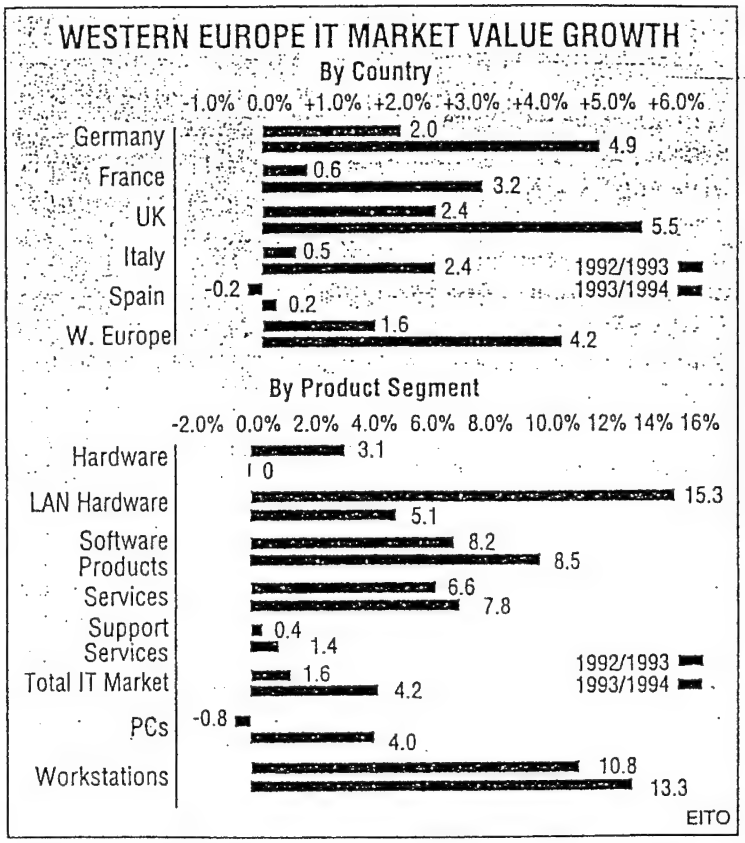
Because **Germany** accounts for 24% of the European IT market, it will determine the market's strength, says a recently published report from the EITO (*see story above*). **"Short term European growth will be a function of how rapidly German users recover their confidence,"** states the report. "If they continue to consider investment in IT a high priority, even during sluggish economic times, it will certainly help drive recovery." The EITO predicts a growth of 2% in the German IT market in 1993, rising to 4.9% in 1994.

The UK IT market will experience higher than average growth, reaching 2.4% in 1993 and 5.5% in 1994. The report credits the growth to an increase in exports and manufacturing output, and an acceleration in business investment.

The French market will continue to be among the weakest in Europe in 1993, with growth predicted to be no more than 0.6%. EITO says France faces very poor growth over the next two years due to the worsening economic outlook.

In Italy, where the IT market has been losing momentum since Q4 of 1992, growth in 1993 is expected to reach only 0.5%. The low expectations are caused by concerns over low levels of foreign orders in general and fewer IT acquisitions by the public sector. In 1994, the market is forecast to recover slightly to a 2.4% level of growth.

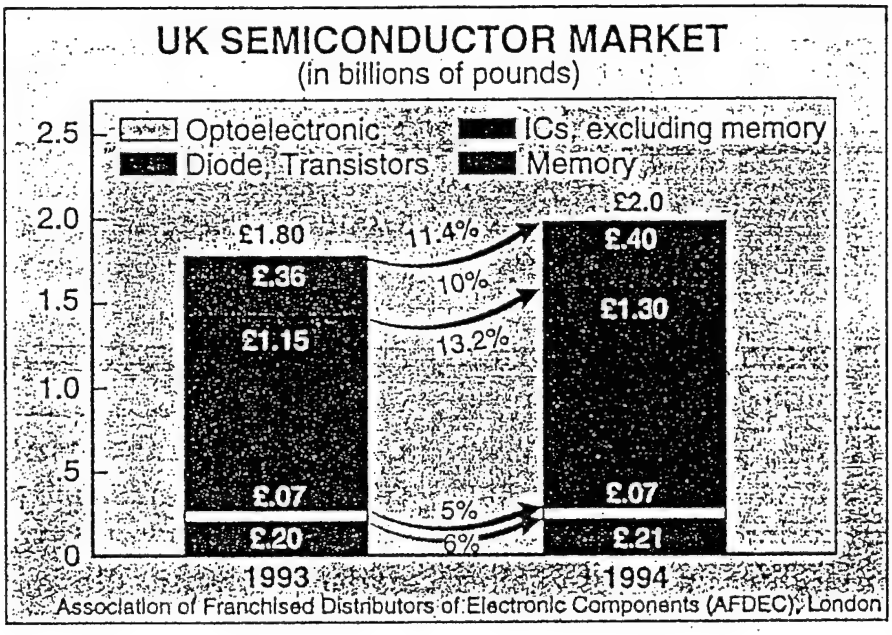
The Spanish IT market, after double-digit growth over several years, fell by 1.2% in 1992. It is expected to decline by 0.2% in 1993, then to grow by 2% in 1994. *—DC*



Source: Claveloux, Denise. "Europe's IT Market to Improve in '94," Electronics, 22 November 1993, 12.

Figure 6.

UK SEMICON MARKET REMAINS STRONG



The UK semiconductor market growth will settle down to a more sober rate next year, according to the **Association of Franchised Distributors of Electronic Components (AFDEC).** The association is **expecting 9.1% growth for all components and 11.4% for all semiconductors.** They say 1994 will see the dominance of sales to the computer makers to be gradually eroded as other sectors increase their demand for more specialized devices. In particular, the AFDEC sees telecom equipment and terminal makers as well as automotive equipment makers spending more. At the same time, a reduction in CPU chip prices will dilute the total value of the market compared with 1993, which was marked by a general switch to more expensive 32-bit processors. They add that growth in the UK market for 1994 will continue to be artificially limited by the capacity of the semiconductor industry, as it had been in 1993. *—PF*

Source: Fletcher, Peter. "UK Semicon Market Remains Strong," Electronics, 10 January 1994, 13.

Figure 7.

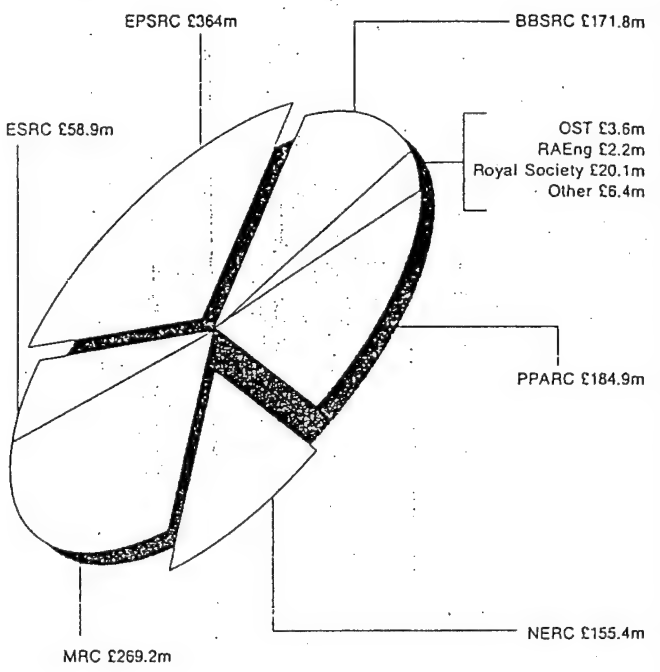
Government goes for wealth creation

The UK is to spend £15.4m of the 1994–95 science budget on new "headroom" initiatives aimed at wealth creation, it was announced last month. Of this, £7.5m is additional money, and the balance will come from reallocated resources.

£3.5m will go to pilot "Realising our potential" awards (ROPAs) aimed at collaborations with industry, and new money will also boost chemistry, innovative manufacturing, genome and immunology research, stochastic mathematics and CASE postgraduate awards.

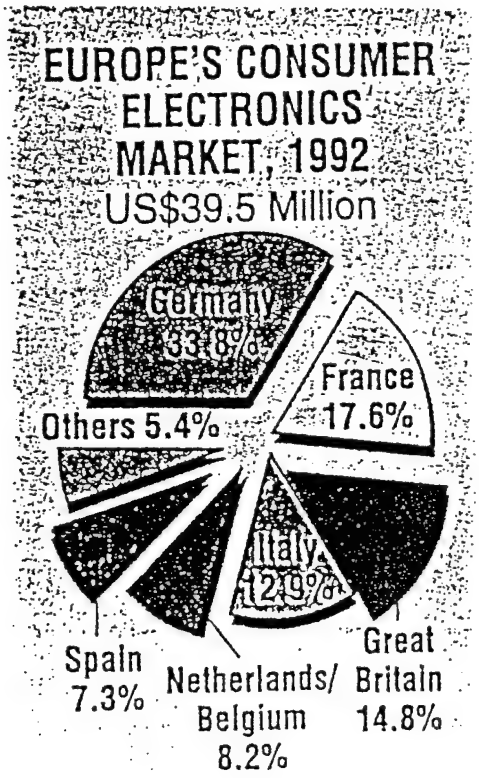
The figure shows the distribution of total funds between the research councils: engineering and physical sciences (EPSRC), particle physics and astronomy (PPARC), natural environment (NERC), medical (MRC), biotechnology and biological sciences (BBSRC) and social sciences (ESRC). □

Allocation of the UK's £1236.5m science budget for 1994–95



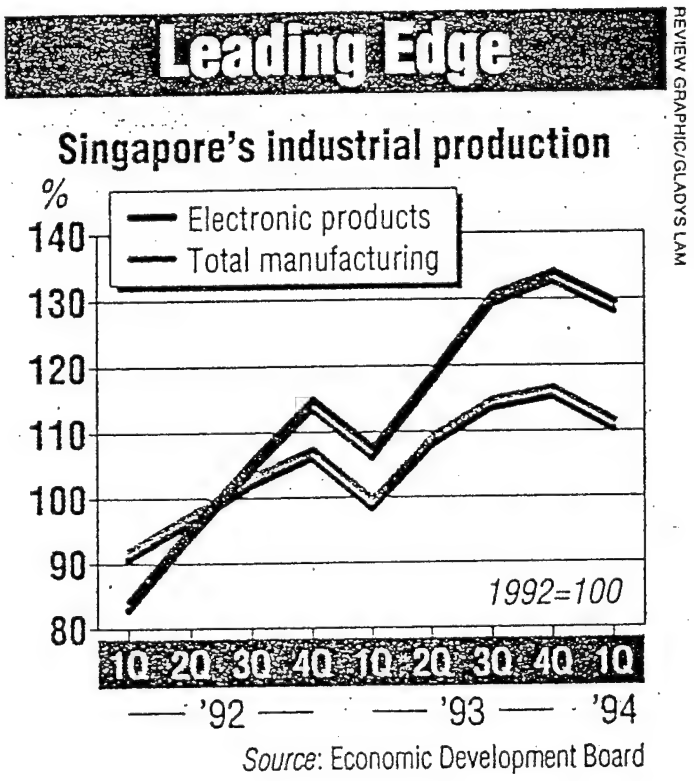
Source: Anon. "Government Goes for Wealth Creation," Physics World, March 1994, 10.

Figure 8.



Source: Vollmer, Alfred. "Europe's Consumer Electronics Spending Slows," Electronics, 13 September 1993, 11.

Figure 9



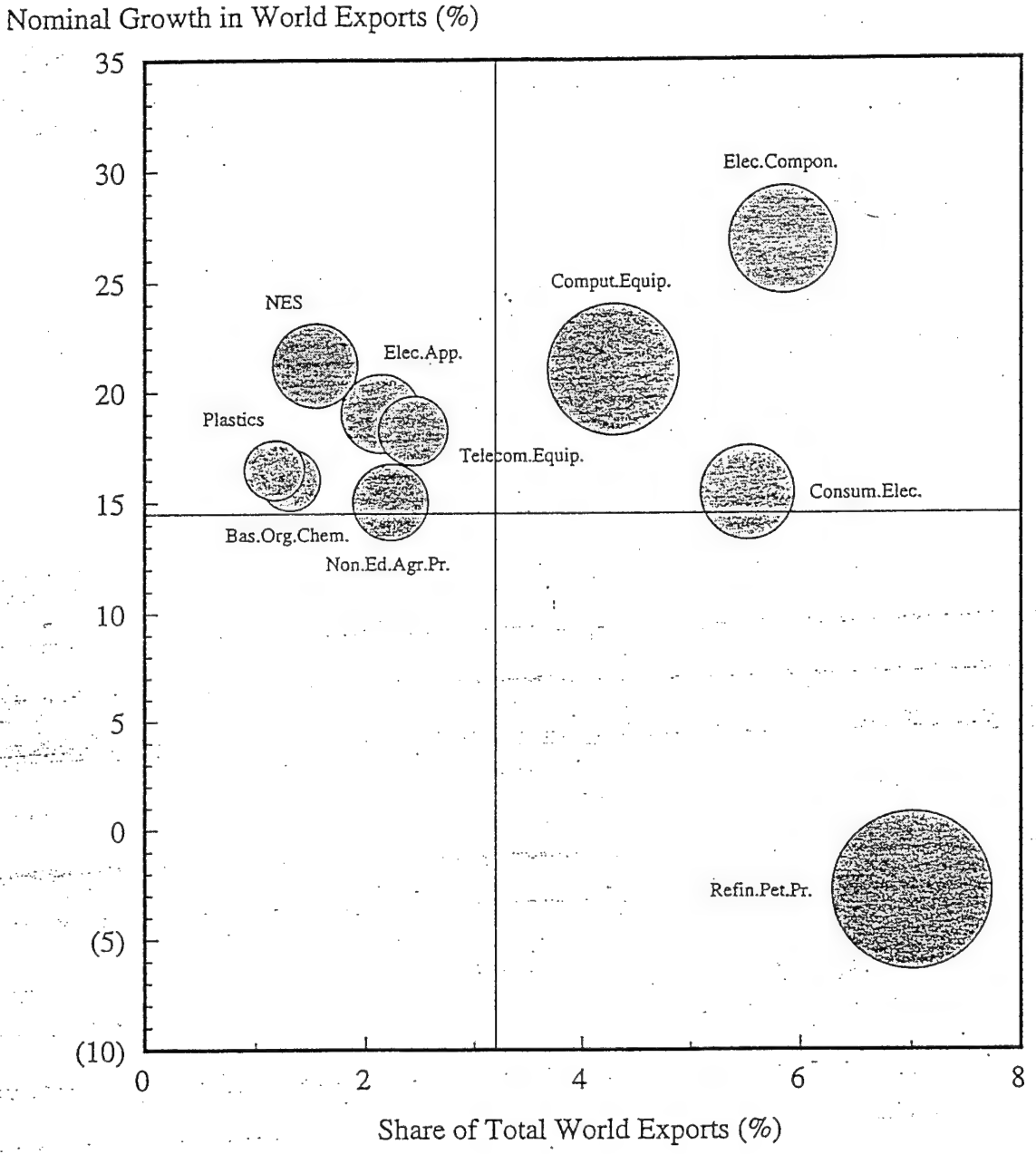
Source: Clifford, Mark. "Strength in Diversity," Far Eastern Economic Review, 2 June 1994, [no page].

Figure 10

Singapore

Portfolio of 10 Leading Export Industries

(1985 - 1989)

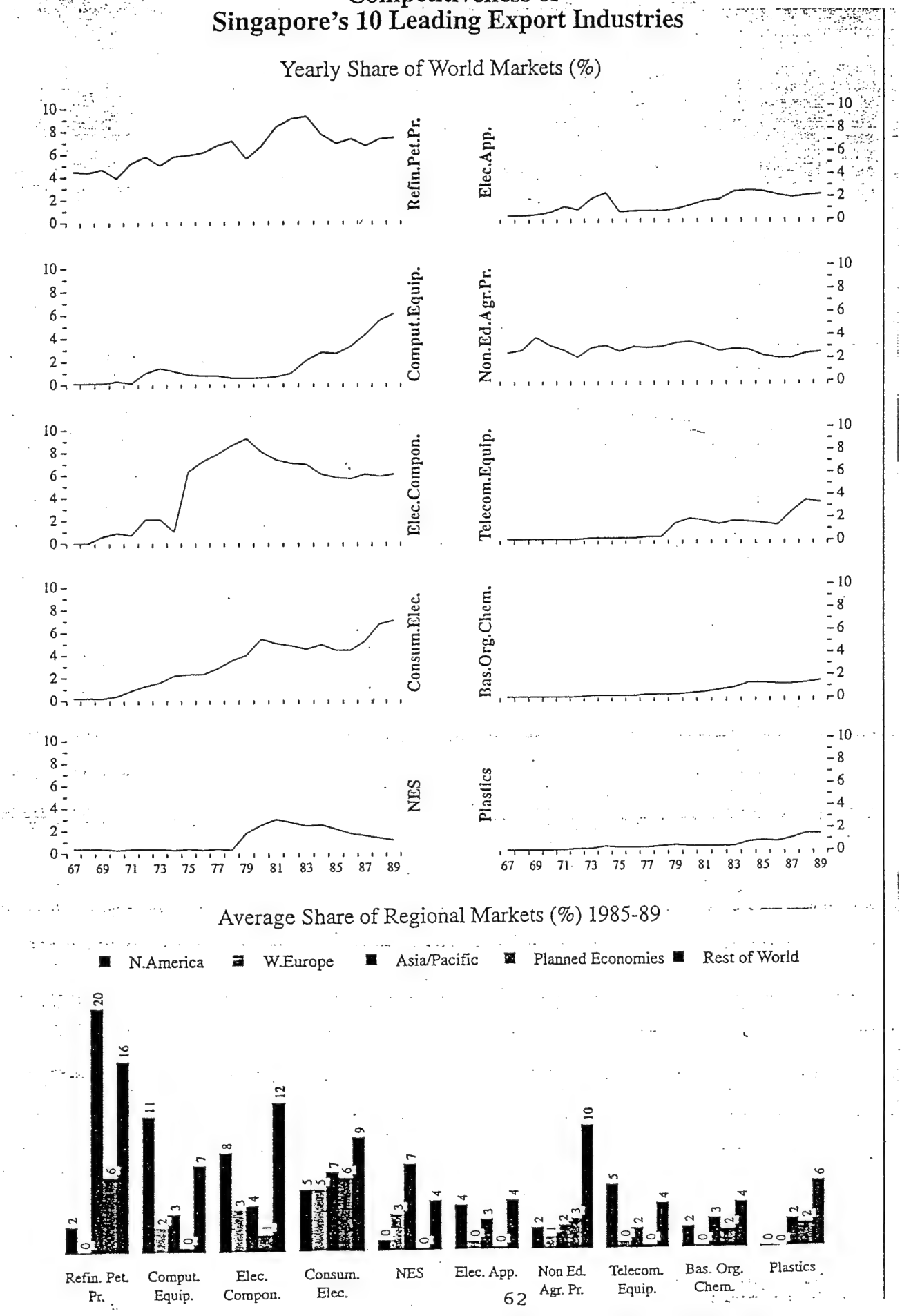


Circles show Total 1985-89 Exports

Weighted Average Growth: 14.5%
Weighted Average Market Share: 3.2%

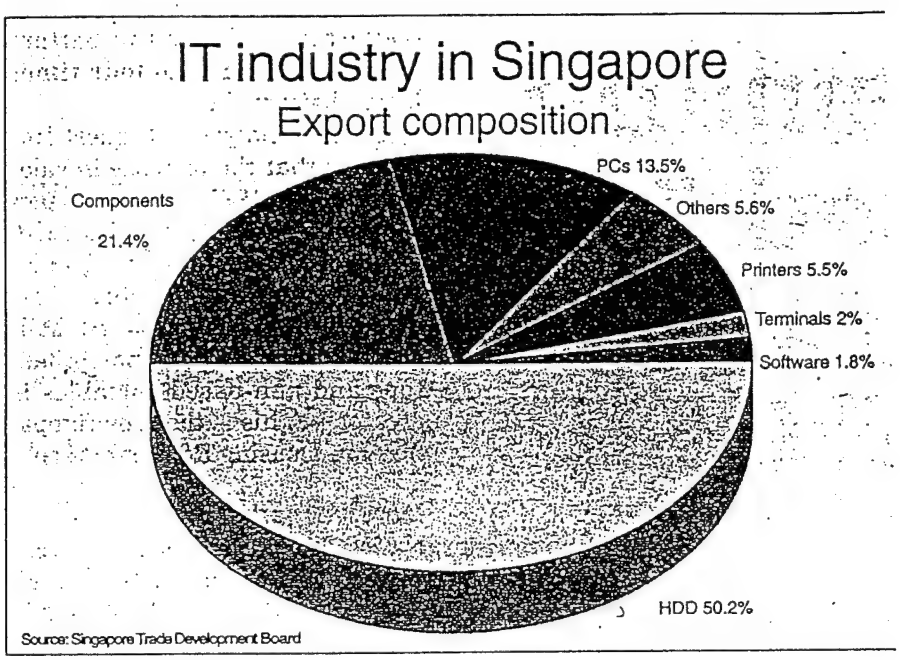
Source: IMD International. The World Competitiveness Report 1991. 146.

Competitiveness of Singapore's 10 Leading Export Industries



Source: IMD International. The World Competitiveness Report 1991. 147.

Figure 12



Source: "IT Industry in Singapore," Electronic Components, January 1994, 19.

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